Power Engineering

AUGUST, 1951

Improved Penstocks Reduce Costs.. 64

Organic Water Conditioning..... 70

Decreasing Starting Current..... 74

Power for Palermo..... 76

Return Line Corrosion.....104

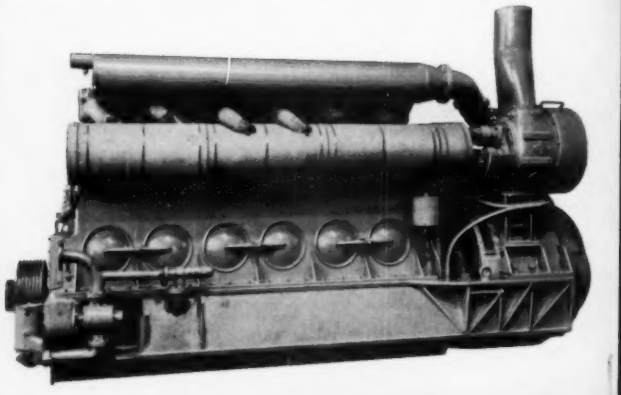
TECHNICAL PUBLISHING COMPANY • CHICAGO, ILLINOIS

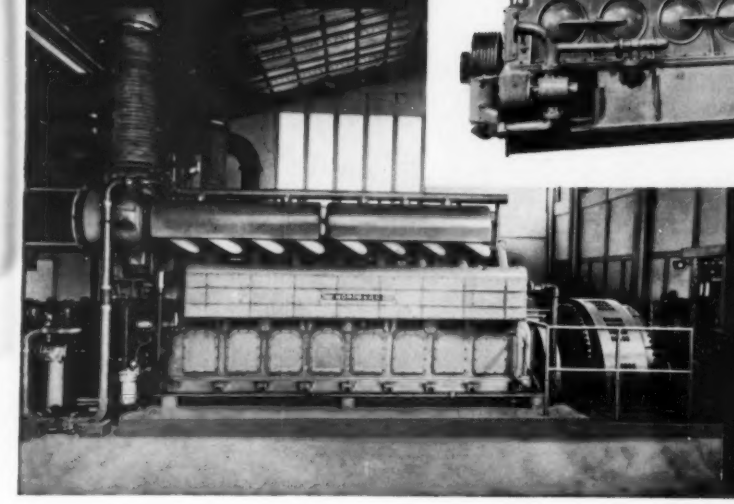
Improved ELLIOTT TURBOCHARGERS

... deliver all the air pressure any diesel can use!

On a 1200-hp Baldwin engine for locomotive service.

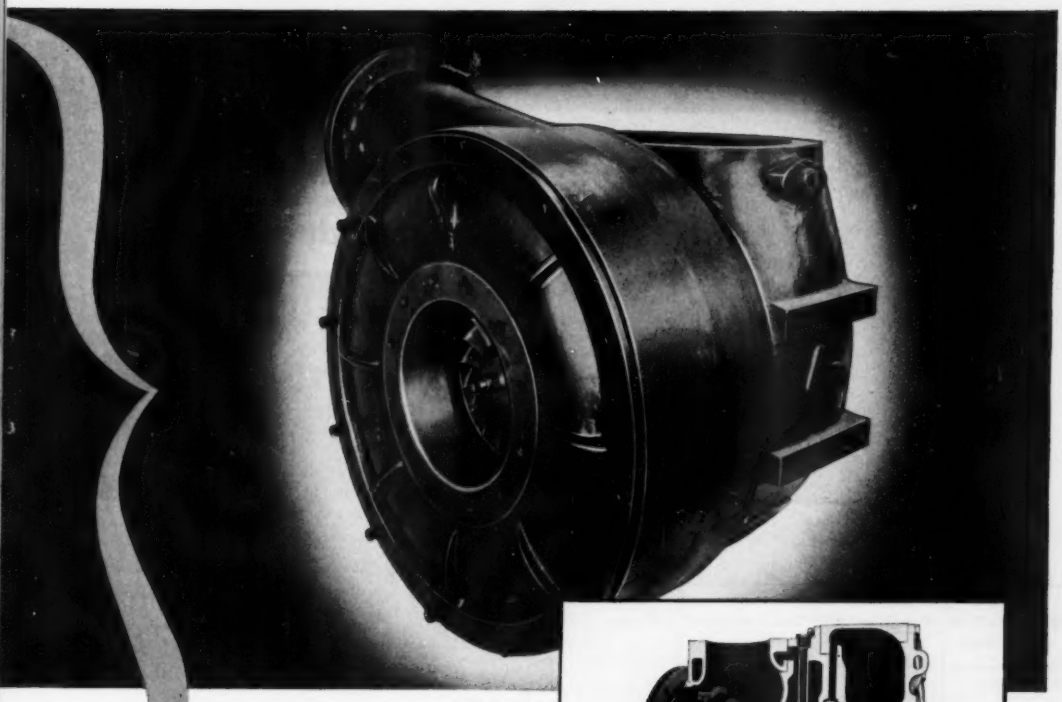
As applied on a 2100-hp 327-rpm 8-cylinder Nordberg engine installation.





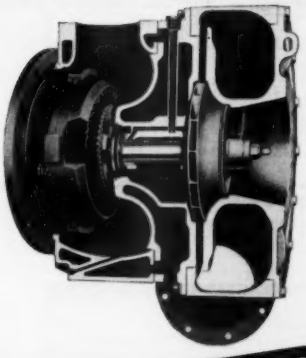
HALF CENTURY OF POWER PROGRESS

1901 1951



Elliott-built turbochargers are now operating on engines, the combined output of which exceeds 6,000,000 bhp. They are accepted and utilized by every builder of slow-speed, heavy-duty four-cycle Diesels, 250 hp and up, in the United States.

Now developed in two types, for high and low pressure, the new Elliott line of turbochargers profits by Elliott engineers' experience of the past ten years in the design and manufacture of these units. The new high-pressure design can deliver blower pressures up to 20 psi, permitting up to 170 bmep in the cylinder. The new line is built in sizes for engines up to 3500 hp. Units can be supplied for a variety of mounting and piping arrangements, and various assembly positions of turbine inlet and blower discharge.



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- Increased overload capacity—
- Constant torque at reduced speeds—
- Reduced consumption of fuel and lube oil—
- Operation unaffected by reversing engine.

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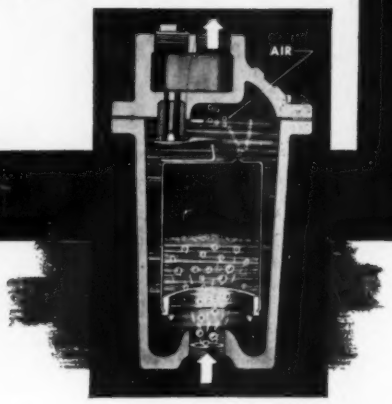
M-104

Armstrong traps vent air to give you hotter machines

HIGHER TEMPERATURES MEAN MORE OUTPUT



PSIG	Temp. of Steam with No Air Present	Temperature of Steam Mixed with Various Amounts of Air. (Per Cent Air by Volume)		
		10%	20%	30%
10.3	240.1	234.3	228.0	220.9
25.3	267.3	261.0	254.1	246.4
50.3	298.0	291.0	283.5	275.1
75.3	320.3	312.9	304.8	295.9
100.3	338.1	330.3	321.8	312.4

THIS TABLE TELLS THE STORY. You can't get the maximum temperature you need unless you get the air out.

PYROMETER TESTS SHOWS 30° TEMPERATURE INCREASE on flatwork ironer rolls at *Peter Bent Brigham Hospital, Boston*, after installation of Armstrong traps which vent air along with condensate.

EVERY time an Armstrong steam trap opens there is a momentary pressure drop which "pumps" air down to the trap from the unit being drained. The air passes through the bucket vent and accumulates at the top of the trap to be discharged along with condensate each time the valve opens.

This one basic benefit of the Armstrong trap is saving industry thousands upon thousands of dollars through faster heat-up and higher, more uniform temperatures with resultant greater output and time and labor savings.

You can have this benefit. The cost of Armstrong traps is small in relation to the efficiencies they effect. Call your nearby Armstrong Representative today.

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SEE OUR CATALOG IN SWEET'S or CEC

HOW TO SELECT the right trap for each application, installation pointers, prices, capacities, other facts and figures are contained in the 36-page STEAM TRAP BOOK. Send for your copy.

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Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

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August, 1951

VOLUME 55 — NUMBER 8

CONTENTS

Improved Penstocks Reduce Costs for High-Head Hydroelectric Plants 64

By Prof. George A. Whetstone

Development of cheaper and more effective penstocks over a period of 25 yrs. Photos of hydro plants in France, Switzerland and British Columbia.

Using and Misusing Organic Water Conditioning Materials .. 70

Knowing when and when not to use organic material in water conditioning is a matter of experience and engineering know-how. Important facts on sludge and scale formation.

Decreasing the Starting Current in Induction Motors 74

Discussion of starting devices to lower the voltage at motor terminals until motor has been brought up to speed.

Power for Palermo 76

By Arthur H. Kuljian and Frank X. Bonnes

This station in Palermo, Sicily, is of particular interest because, built largely of American equipment, its design involves distinctive European principles.

The Practical Engineer and Electrician Section. Contents 79

16 pages packed with practical operating and maintenance helps for every type of power plant. See complete separate contents page.

A Synchronous Motor at Work 100

By Denard L. Gusler

Improving power factor by putting an old generator and old motor to work in a new money-saving system. A little effort and headwork can find uses for old equipment which can reduce power costs in many plants.

Plant Stops Return Line Corrosion — Saves $14,200 Per Year 104

By Erle Elliott and Philip J. Gaughan

In June 1950 we published an exclusive article on Filming Amines to Prevent Corrosion. This article gives a detailed engineering account of results of the method at Glen L. Martin Co.

How to Clean Your Turbine Lubricating System After Service 111

By F. E. Rosenstiehl

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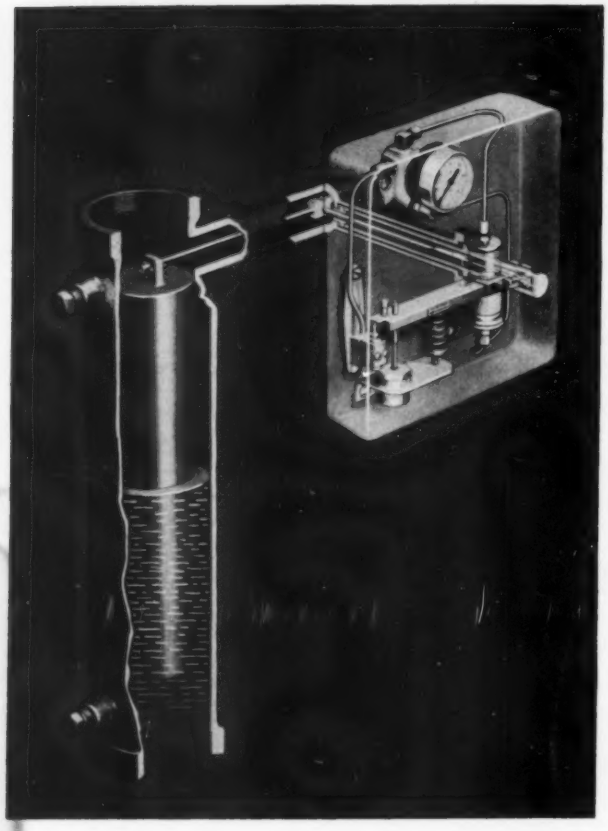
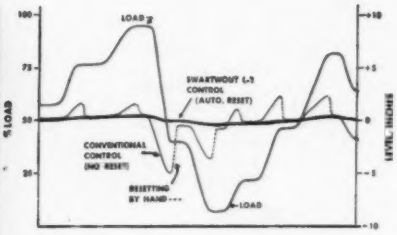
Hold liquid levels within ±1/2 inch automatically with Swartwout L1 Displacement Type Controls



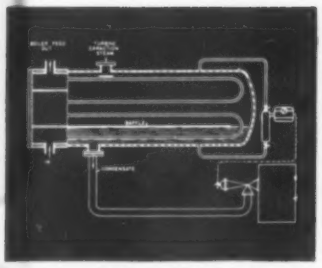


1 Precise control of liquid level from no load to full load without manual readjustment is provided by Swartwout L1 Controls. Setback and reset features compensate for quick-changing loads or long process lags . . . eliminate any tendency to cycle or hunt, yet permit control within narrow range of ±½ inch. Graph *(above)* shows precision of L1 compared with conventional control on applications where level must be maintained within ±½ inch.

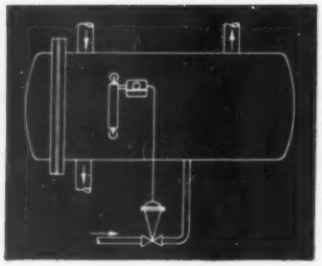
Operating on balance of forces principle, there is little actual movement of parts. Torque tube design eliminates stuffing boxes . . . gives continuous leakproof operation. Since changes in liquid level vary effective weight of displacement type float, L1 Controls can also be used for throttling over full length of float, available in lengths from 15 to 120 inches. A-3696

Swartwout

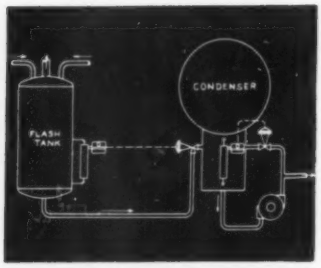
POWER PLANT EQUIPMENT



2 Horizontal Subcooled Heaters—L1 Control holds level to ±½ inch, never lets condensate cover tubes that should be exposed to steam . . . never exposes tubes that should be covered with condensate.



3 Evaporators—Swartwout L1 Displacement Type Control holds level within ±½ inch . . . prevents carryover of solids and contamination of boiler feed water. Increased plant efficiency results.



4 Flash Tanks—Level maintained, in some installations, by L1 Control draining to condenser. Hot well level precisely maintained by controlling condensate recirculation from pump discharge.

SEND FOR BULLETINS S-15-A, S-208-A • THE SWARTWOUT COMPANY, 18511 EUCLID AVENUE, CLEVELAND 12, OHIO

ENGINEERS' PREVIEW

CHEAP SKATE now lubricates Diesel flanges. Port Huron & Detroit railroad is now using "dag" colloidal graphite in its "Nervous Nellie" to lubricate all Diesel-engine wheel flanges.

Developed by W. N. Boyd, General Superintendent of the line, the applicator, called "Nervous Nellie", consists of a small cylindrical tank or container with a felt wick projecting through a tube, welded on a common roller skate found in any hardware or toy store. It travels in an adjustable guide mounted on the top of the side frame of the truck, at right angles to the wheel flange, and has a lateral movement of 1 to 3 in. when the locomotive is in motion. The wick draws the lubricant from the container by capillary action and is always moist. The applicator makes occasional contacts with the flange on straight track and continuous contact on curves where the track has elevation. It exerts little or no pressure and deposits a light film of graphite on the flange. Notable advantage is that on curves the flange on the high side gets continuous lubrication.

★ ★ ★

ONE OF THE OLDEST regions in this country's iron and steel industry is scheduled to return to steelmaking prominence with the construction of a new plant next Spring at Morrisville, Penna., on the Delaware River. Another steel company has purchased a large site near Paulsboro, N. J.

The iron industry of Eastern Pennsylvania began in 1716 when Thomas Rutter built a bloomery in Berks County. Durham furnace was built in 1727, about 35 miles northwest of the site of the Morrisville plant. This plant helped supply Continental troops during the Revolution.

For the most part, Pennsylvania ironworks prior to 1800 were within a 40 mile radius of Philadelphia, their only major market. There were also two small furnaces in that city for converting iron into steel. About 1750, iron manufacture began to extend west of the Susquehanna River. The now prominent Lehigh Valley district was first developed about 1805.

The early iron industry of Southern New Jersey was based on the bog ores of the Little Egg Harbor and the Wading River. The successful manufacture of iron began about 1730 with the rebuilding of the Mount Holly furnace. Many others were built in the late 1700's and early 1800's.

★ ★ ★

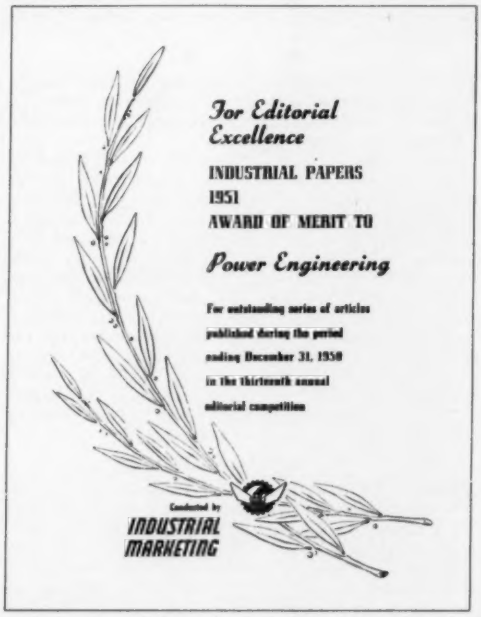
BESSEMER converters now can be made to increase their output and thus provide more hot metal for open hearth steelmaking by injecting oxygen into the normal air blast and charging more scrap.

National Tube Co. experimented with use of oxygen in bessemer converters when a blast furnace went out of operation late last year, causing a shortage of molten metal for the open hearth steelmaking furnaces. By using 4000 to 6000 cu ft of oxygen per "blow," the normal steel scrap charge in a 30-ton operation can be increased by about two tons, and blowing time can be decreased by about one minute. This method offers a practical means for melting additional scrap to increase ingot tonnage when a deficiency of hot metal exists. Experience with oxygenated bessemer blows proved so successful that one converter has continued in such service although all blast furnaces are now in operation.

AGAIN POWER ENGINEERING has hit the target — although not exactly in the bull's eye — in the now famous editorial competition for business magazines held each year by *Industrial Marketing*, one of the outstanding publications in the advertising field: (We say again because the first prize in this same contest was awarded to us in 1946 — again for best series of articles, that on Atomics by Editor Andrew W. Kramer.)

The award for 1950, shown below, was made for the outstanding series of articles on Basic Power Plant Figuring, by William H. Engelman, which ran in POWER ENGINEERING throughout 1950. These articles are based on practical calculations and data tables used by Mr. Engelman in conducting classes in steam power engineering sponsored in Cleveland, Ohio by the IUOE, the City of Cleveland, the U. S. Department of Labor and many of the private industries of Cleveland.

Mr. Engelman has been a mechanical engineer in the Department of Water & Light, City of Cleveland, for many years. This background, plus his years of industrial and power plant experience, have shown him the sort of practical, down-to-earth information that power plant men need to solve the practical problems they meet every day on the job.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INDUSTRIAL PAPERS
1951
AWARD OF MERIT TO
Power Engineering
For outstanding series of articles published during the period ending December 31, 1950 in the thirteenth annual editorial competition
Conducted by
INDUSTRIAL MARKETING

We began publishing the Basic Power Plant Figuring articles early in 1949 and at that time, knowing what Mr. Engelman had in his voluminous files and notebooks, we knew we had something outstanding.

The truth of this has been indicated by scores of letters from POWER ENGINEERING's readers, who clamor for tear sheets, reprints and more articles. The demand for Basic Power Plant Figuring in book form is tremendous. We always knew it was great stuff.

To have our judgment confirmed not only by our readers but also in this contest, in which the competition

includes all the leading and most influential business and industrial magazines of the country, is naturally most gratifying to the editors of POWER ENGINEERING. But after all, it is Mr. Engelman who should stand in the spotlight and take the bows. He wrote the material. Take another bow, Mr. Engelman. You've done a great job and we're proud to be associated with it.

★ ★ ★

WHAT WILL the 1970 airplane be like? Grover Loening, associate of the Wright brothers, made these predictions in Feb., 1951, issue of *Pegasus* (Fairchild Engine and Airplane Corp.): Cruise at 1200–1500 miles per hour, externally much quieter, land almost vertically, be built largely of titanium, have auxiliary engine for taxiing, variable sweep back, less instruments for pilot and many more automatic operations, be fireproof in crashes.

★ ★ ★

FIRST MOVING STAIRWAY on a warship has been installed on the Navy aircraft carrier USS Oriskany. On this stairway, the Navy jet pilots ride to the flight deck carrying their 40 lb of gear from the second deck to the flight deck 28 ft above in a few seconds. Formerly they had to rush up a long flight of stairs (a companionway, to you sailors) and usually arrived winded. Now they arrive ready for immediate take-off as required by the carrier's split-second flight schedule. This moving stairway was built by Westinghouse Elevator Div.; and five other aircraft carriers are being equipped with similar devices.

★ ★ ★

IN A SPEECH before the New Jersey Bankers Association Convention recently, Commissioner Henry D. Smyth, U. S. Atomic Energy Commission, made the following interesting statement:

"Heat is the source of all the energy on which modern civilization runs. Thus, it is obvious that in nuclear reactors we have a potential source of energy. In fact, it is a very great source of energy since one pound of uranium 235 could release as much energy as can be obtained from burning 1300 tons of coal. The major difficulty arises from the fact that heat energy can be converted into useful energy only if high temperatures can be used. I need not go into the technical problems which this condition imposes on a reactor. *I will only say that we believe they can be met, that we expect to have power-producing reactors running within a year or so*, but that we do not yet know when or whether such reactors using uranium as fuel will be able to compete economically with power plants burning conventional fuels." (Italics ours)

★ ★ ★

ROSIE THE RIVETER may be coming back into industry again. Some valuable hints for fitting her into the production setup are given by Frances Whitelock, Labor Economist, Women's Bureau, U. S. Dept. of Labor, in a recent article in *Mill & Factory*. In World War II, Rosie didn't get very much training for her job, especially in the beginning. This time, however, the new Rosie will deserve it and a number of important things can and should be done to work her into the scheme of things much more smoothly and effectively than before.

Whether or not we shall have her colleagues, the sisters of the steam gage, back in the power plant is another question. We have asked about this recently in a number of plants, and the prevailing opinion right now seems to be that the sisters will not be really needed, save for a genuine and very sudden national emergency. However, it was amazing to see what the sisters could accomplish last time and they can do it again if they have to.

ENGINEERS must make clear the requirements and define the limits of their profession so that "shadow-land engineers" cannot trade on the reputation of the profession to its detriment, the ASME was told at a recent meeting. John D. Waugh, associate with Pendray & Leibert, public relations firm of New York City, said engineers have a responsibility to maintain the prestige of the profession and assure its attraction for the best qualified men.

Engineers, declared Mr. Waugh, should be aware that their public relations "symbol" has a direct bearing on their income and the security and prestige of their positions.

"Individually and collectively," he said, "engineers have an important stake in improving their public relations so that the profession will achieve wider public understanding, with its attendant benefits. To advance their public relations standing, engineers should relate their activities to the public interest by making more widely known the role of the engineer in building modern society."

Mr. Waugh said the indifference on the part of the public to the many achievements of the engineering profession is *not* due to the technical nature of the engineer's work. Scientists, often working in the purely abstract and highly technical realm, have done a superb job of dramatizing their profession, he declared. Their stories, he said, are told and retold, their counsel is sought, and their advice is very frequently accepted, adding that the very fact of their recognition should dispel the idea that the public is not interested in technical subjects and the personalities behind them.

"What the scientists have done to capture the imagination of the public is to strip abstract and mathematical subjects of their technical embroidery and explain them in terms of human interest and public benefit," Mr. Waugh declared. "The results of their research imply progress in national defense, public health, advancing living standards, and many other subjects of general concern and interest. Engineers could do the same thing quite as capably in their fields of endeavor and establish a greatly improved symbol in the public mind."

★ ★ ★

THERE ARE many ways to achieve the increased productivity in the United States that everybody agrees we need. One of the methods that merits considerable attention is the increase in productivity that may be produced through safety and accident prevention. An interesting paper on this was delivered by Hjalmar W. Johnson, Vice President of Inland Steel Company, recently before the AISI. He showed how in one of the plants of his company the number of disabling injuries per million man hours work has decreased from an average of 21.82 from 1911–1920 to an average of 8.05 for the period 1941–1950. He reviewed the various factors in producing further improvements in the safety record, emphasizing that the amount of time spent on accident prevention is not so important as how effectively the time is spent.

★ ★ ★

METAL RESOURCES, upon which rest the security and freedom of the world, will be thoroughly discussed by top-ranking metal scientists and engineers from the free nations of Europe, Africa and Asia, as well as from North and South America, when they gather in Detroit, Mich., October 14–19, 1951, to attend the World Metallurgical Congress, first international conclave of its kind. Full details from American Society for Metals, William H. Eisenman, Secretary 7301 Euclid Ave., Cleveland, Ohio.

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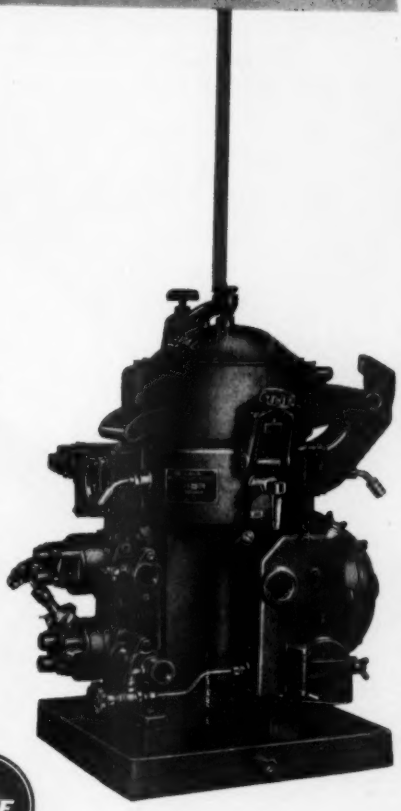
De Laval protection not only is double—it is constant in efficiency during the entire length of time that the Purifier is in action.



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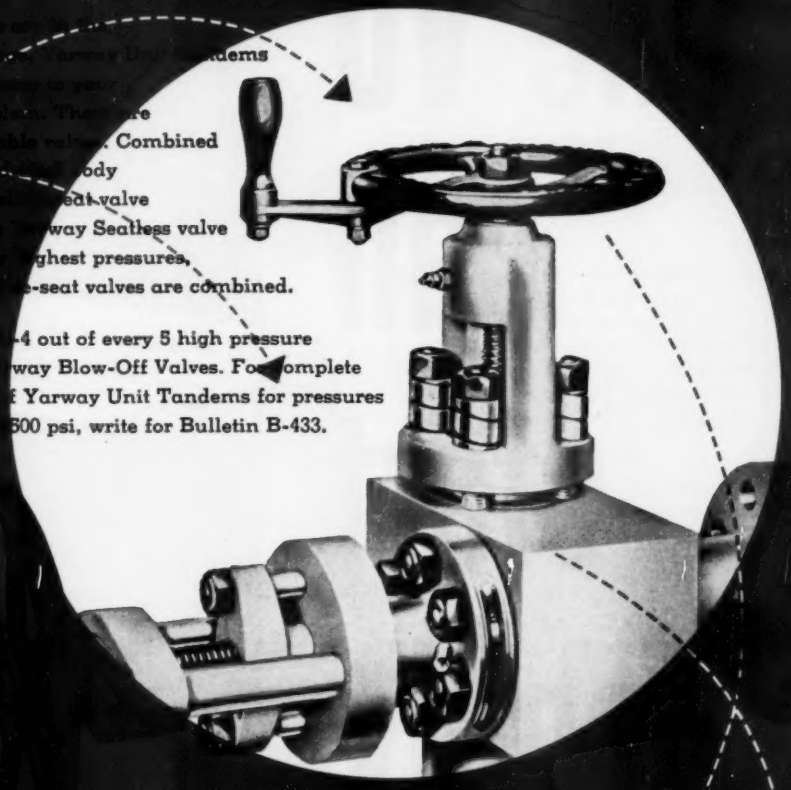

...dems

...Combined
...body
...seat valve
...way Seatless valve
...ghest pressures,
...-seat valves are combined.

...-4 out of every 5 high pressure
...way Blow-Off Valves. For complete
...f Yarway Unit Tandems for pressures
...500 psi, write for Bulletin B-433.

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BLOW-OFF VALVES

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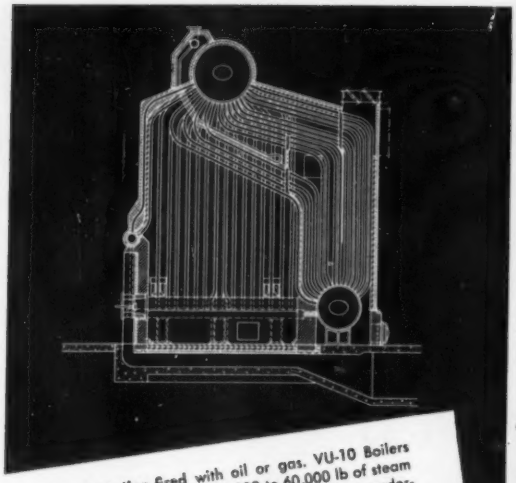
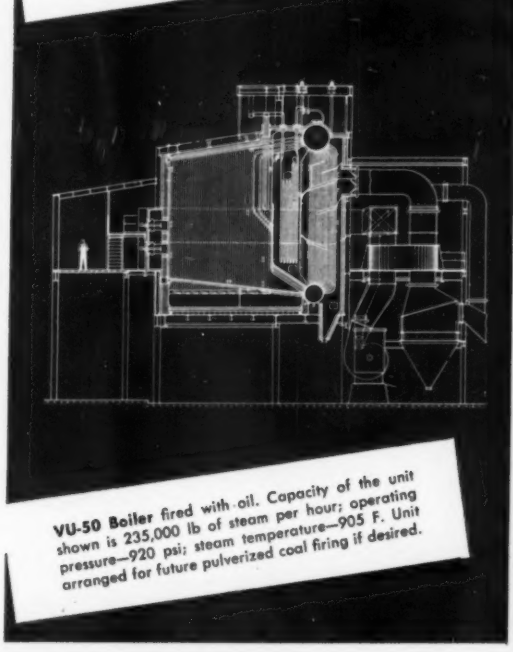


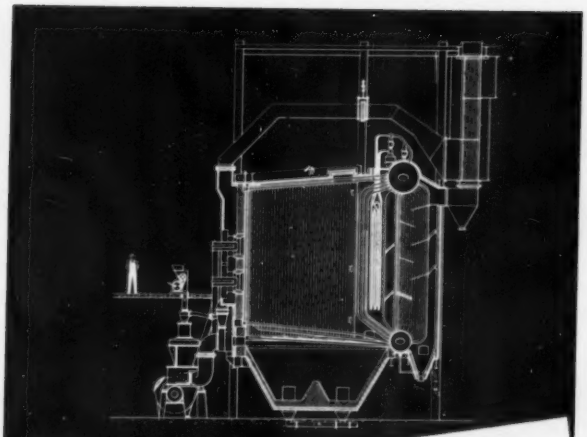
VU-10 Boiler fired with oil or gas. VU-10 Boilers range in capacity from 10,000 to 60,000 lb of steam per hour. They may also be fired by spreader, underfeed or traveling grate stokers.



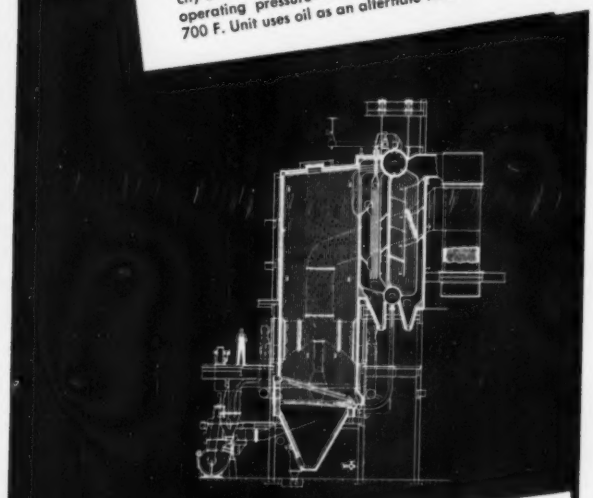
VU-50 Boiler fired with oil. Capacity of the unit shown is 235,000 lb of steam per hour; operating pressure—920 psi; steam temperature—905 F. Unit arranged for future pulverized coal firing if desired.

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



VU-50 Boiler fired with pulverized coal. The capacity of the unit shown is 60,000 lb of steam per hour; operating pressure—410 psi; steam temperature—700 F. Unit uses oil as an alternate fuel.



VU-50 Boiler tangentially fired with pulverized coal and/or blast furnace gas. Capacity of unit shown—125,000 lb of steam per hour; operating pressure—850 psi; steam temperature—750 F.

With fuel costing what it does today, it is more important than ever before to select a boiler that will assure the most efficient performance possible. That is why so many companies who watch steam costs closely have acquired sizable families of Vertical Unit Boilers. For example:

A Chemical Company ordered two VU Boilers in 1939. In 1946 five more were ordered for three of their other plants. In 1949 another was ordered for one of these same plants, and in 1950 two more units for a fifth plant. In 1951 three more units were ordered for still another plant — thirteen units for six plants in twelve years!

An Electric Utility Company ordered its first VU in 1941. In 1945 it ordered a second VU for a different plant. For another of its plants one unit was installed in 1946 and two more in 1947. In 1949 a VU was installed in a fourth plant, and in 1950 one was installed in a fifth plant. A total of seven boilers in five different plants.

A Sugar Company ordered two VU Boilers for one of its plants before the war. In 1946 it ordered a VU for a second plant. And in 1950 another VU was installed in this same plant.

A Steel Company now has a total of fourteen VU Boilers in four different plants. Starting with an installation of two units in the early thirties, it has reordered six times. The most recent installation of two units at one of its plants was completed in 1948.

* * *

This is just a small sample of the hundreds of companies that have ordered and *reordered* the VU Unit. They have found *through their own experience* that the advanced design, sound construction and consistent reliability of the VU Unit mean *lower steam costs.* Once you have a VU in service you soon know why it is that so often *one* VU starts a family. B-494

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C-E

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that are entirely new, distinctive in design . . . are another major addition to Marley's long list of achievements in cooling tower advancement.

Laminated Fan Cylinders are the sturdiest ever applied to cooling towers. Built entirely of overlapping layers of redwood boards, they are structurally strong . . . uniformly strong at every point. No metal shape rings or clamp strips are needed; there is nothing to corrode, loosen or vibrate. Laminated Fan Cylinders are built of the same material as the towers they serve . . . built to last as long.

MODERNIZE ANY LARGE INDUCED DRAFT TOWER

Laminated Fan Cylinders will reduce maintenance time and upkeep expense on *any* large cooling tower. No painting, no replacing rusted metal parts — you check fan cylinders off the maintenance list when you install modern Laminated Fan Cylinders. Engineers have ordered many of these fan cylinders for replacement since Marley recently made them available.

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OPERATION: FLEXIBILITY

A CLEAVER-BROOKS STEAM BOILER GIVES YOU:

✓ **Quick, effortless response to fluctuating steam demands.**

✓ **Equally high efficiency (80%) operating with oil or gas.**

Fluctuating steam loads are no problem when you have a custom-planned Cleaver-Brooks boiler in your plant. Whether your demand is heavy or light, steady or variable, these sturdy heavy-duty boilers respond instantly to your steam needs. Even with loads as low as 30% of rating, Cleaver-Brooks boilers operate with a flat 80% efficiency.

Cleaver-Brooks boilers burn either oil or gas . . . either fuel is properly proportioned to meet your steam demand and need. No banking of fires or loss of valuable heat during low load periods. You benefit with lower fuel bills, less maintenance, reduced operating costs.

If you are considering a change in your present boiler plant—think about flexibility — and get the complete facts about Cleaver-Brooks custom-planned boilers. Cleaver-Brooks self-contained boilers 15 to 500 HP, 15 to 250 lbs., p. s. i. — oil, gas, combination oil and gas firing. CLEAVER-BROOKS COMPANY, 356 East Keefe Avenue, Milwaukee 12, Wisconsin.

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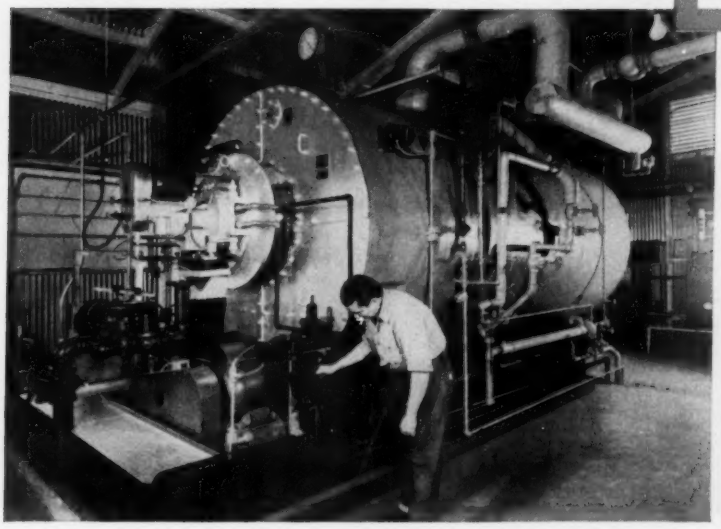
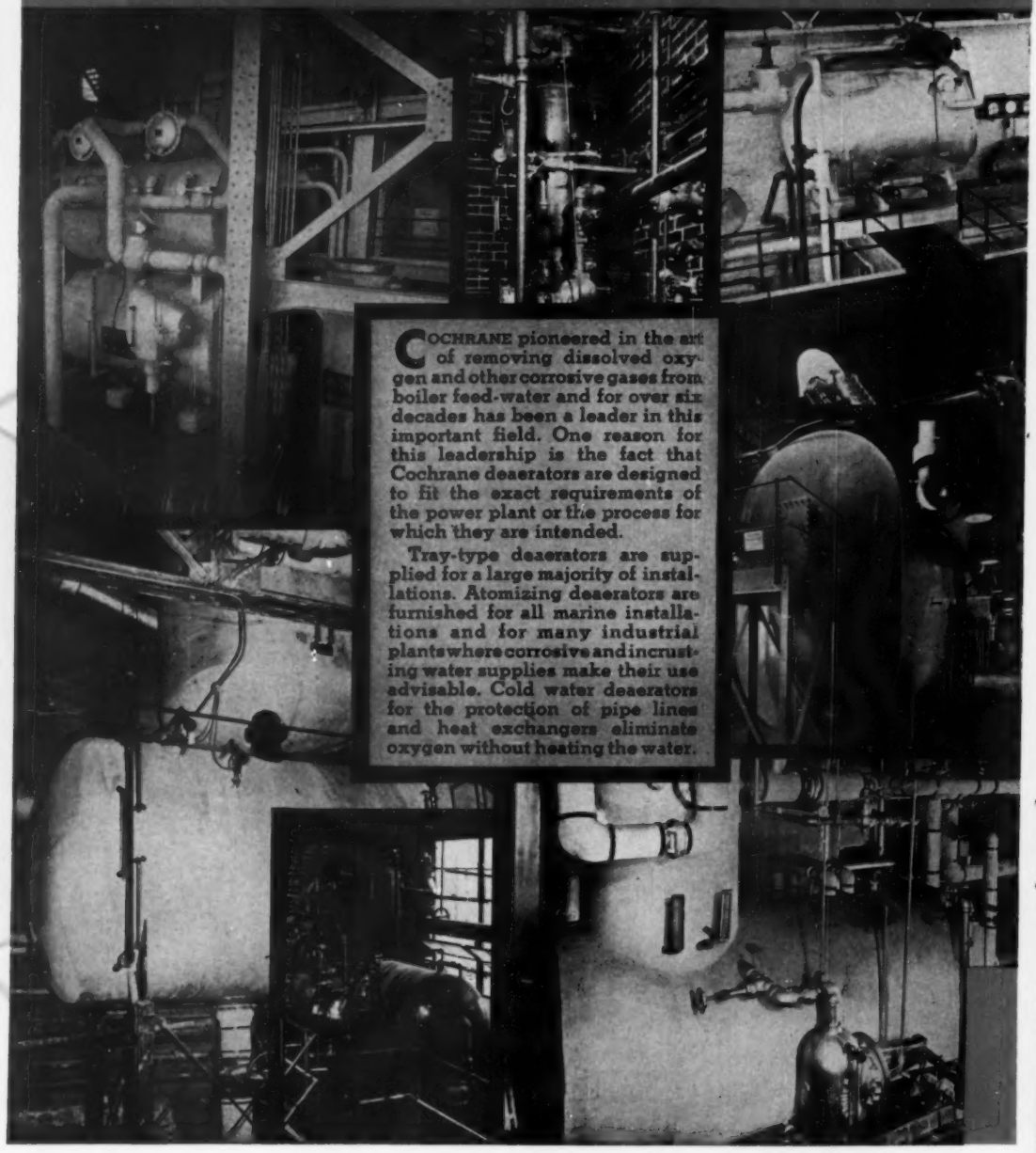
STEAM BOILERS
the first and finest of their class



Write for a Cleaver-Brooks Steam Boiler Catalog.

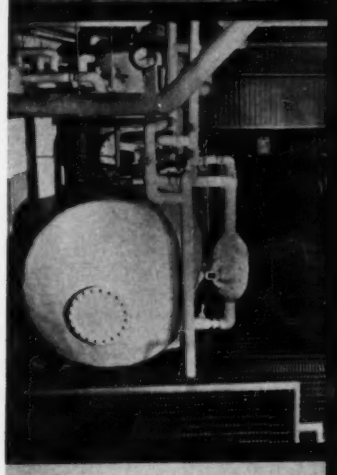
DEAERATION



COCHRANE pioneered in the art of removing dissolved oxygen and other corrosive gases from boiler feed-water and for over six decades has been a leader in this important field. One reason for this leadership is the fact that Cochrane deaerators are designed to fit the exact requirements of the power plant or the process for which they are intended.

Tray-type deaerators are supplied for a large majority of installations. Atomizing deaerators are furnished for all marine installations and for many industrial plants where corrosive and incrusting water supplies make their use advisable. Cold water deaerators for the protection of pipe lines and heat exchangers eliminate oxygen without heating the water.

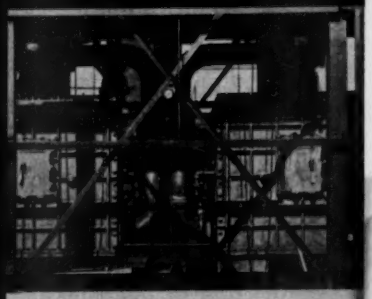
from A to Z

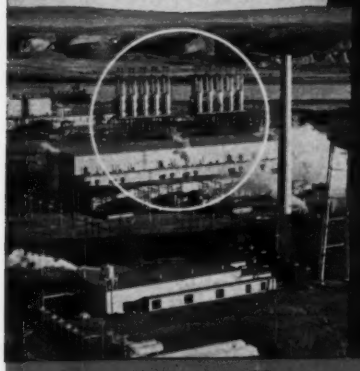


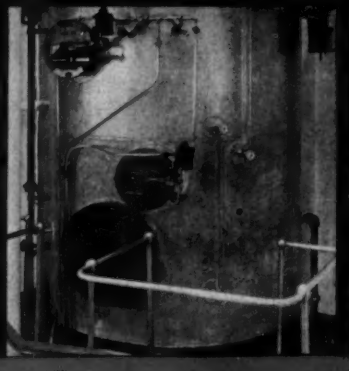
COCHRANE deaerators are supplied in a variety of different constructions. Welded rolled plate construction using low carbon steel, alloy steels and other metals is furnished for all pressures and capacities. Cast-iron shells of heavy, deeply-ridged sectional plates, with caulked joints, may also be supplied.

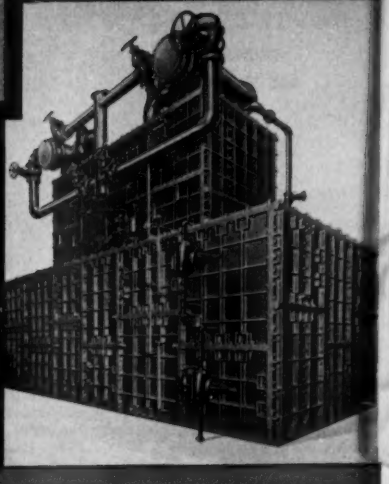
Special designs to meet unusual conditions, such as space limitations, are often necessary and Cochrane's long experience in this field invariably results in considerable savings in the cost of the power plant by obviating changes in building construction or in the arrangement of the equipment. Installations shown on these two pages are typical. Write for details.

COCHRANE CORPORATION
Philadelphia 32, Pennsylvania









COCHRANE

COPES *Applied to Hydraulic Couplings*

GIVES PRECISE FEED AND LEVEL CONTROL

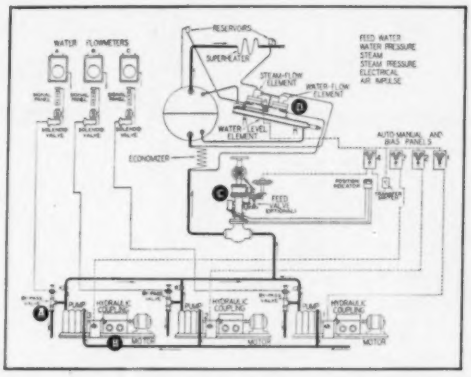
at PLANT YATES *of* GEORGIA POWER COMPANY

Remarkably close feed-flow and water-level control is being demonstrated daily by the COPES Balanced Flow Control at Plant Yates of Georgia Power Company, Newnan, Georgia. Units 1 and 2 went into service late in 1950.

Each unit includes a 3-drum, dry-bottom, radiant-type Combustion Engineering-Superheater boiler designed for a maximum continuous rating of 975,000 pounds per hour. Loads have been carried as high as 1,050,000—as low as 250,000—pounds per hour.

The COPES Control, applied through the hydraulic couplings of the feed pumps, matches feed flow almost perfectly to steam flow, and stabilizes water level within plus-or-minus one inch. Independent of meters and other controls, it can remain on full-automatic when they must be out of service for any reason. Duplicating COPES Control is on order for Unit 3, scheduled to start operation next winter. For complete data on COPES Balanced Flow at this utility write for Bulletin No. 489.

NORTHERN EQUIPMENT DIVISION
Continental Foundry & Machine Company
812 GROVE DRIVE, ERIE, PENNSYLVANIA



Schematic shows COPES Balanced Flow Control installed for each boiler at Plant Yates. Responsive to three influences—steam flow, feed flow and water level—COPES applies air impulses to position individual controller for the hydraulic coupling of each motor driven pump. Two pumps are normally paralleled, with third on standby, but any pump can be cut in or out by pushing the button to start or stop its motor.

Feed valve is normally wide open, but can be cut into automatic service at any time.

COPES Minimum Flow Control protects the pumps against overheating on light loads.

Headquarters for **Feed Water Regulators • Pump Governors • Differential Valves • Level Controls • Hi-Low Alarms • Reducing Valves • Desuperheaters**

(A) COPES Recirculating Valve used with the Minimum Flow Control System to protect the pumps on light loads.

(B) Air impulses from the COPES Balanced Flow Control actuate this controller on the hydraulic coupling to control the speed of each boiler feed pump.

(C) The COPES Feed Valve, installed in a vertical line, is normally wide open but may quickly be placed on fully-automatic, if and when this is desired.

(D) The COPES Balanced Flow Thermostat has steam-flow and water-level elements mounted rigidly on the frame of the water-level element. It is rugged.

COPES BOILER FEED WATER REGULATION

PACIFIC PUMPS

PACIFIC PUMPS

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Custom-Built Boiler Feed Pumps

in any size...

to fit your feed installation

The history and background of Pacific Boiler Feed Pumps is a history and background of the design and manufacture of centrifugal pumps for the most extreme temperatures and pressures called for by industry. Pacific designed the solid forged steel case for high pressures and high temperatures... pioneered the use of chrome alloy steels for impellers, diffusers and all other internal parts, as well as developing many other features now recognized as standard in the industry. Pacific Boiler Feed Pumps in operation include small units of the vertical type for 47,700 lbs. per hr. and 710 psig discharge pressure to very large units of the horizontal type for 800,000 lbs. per hr. and 2430 psig discharge pressure. Pacific has the solution for your boiler feed problem.

Bulletin 109 Gives Details

PACIFIC *Precision Built* PUMPS

BF-11

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The Raybestos-Manhattan packings in the stuffing box of this hydraulic accumulator ram play an important part in the machine's successful operation. The complete line of R/M packings and gaskets plays an important part in the successful operation of valves, compressors, pumps, hydraulic and other equipment of all types. The R/M distributor near you will gladly help select the right R/M packing or gasket to meet your needs. Or write for the new R/M Packing Catalog.

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Here's ONE solution to a water shortage

. . . but not a very dependable one!

When an industrial plant begins running short of water, smart management calls in recognized professional help—*and fast!*

For the time to act on a water shortage is *before* the problem becomes acute. Qualified consultants have shown scores of companies how to do the same jobs with less water, how to re-use water, how to recover (for re-use, or for sale as by-products) valuable materials from waste water — and even how to improve the quality of their regular products!

For an economical as well as an effective solution to *your* plant's water shortage, or for help on any industrial waste-treatment problem — call on men with wide experience as specialists in this field. *Call on Gilbert Associates!*

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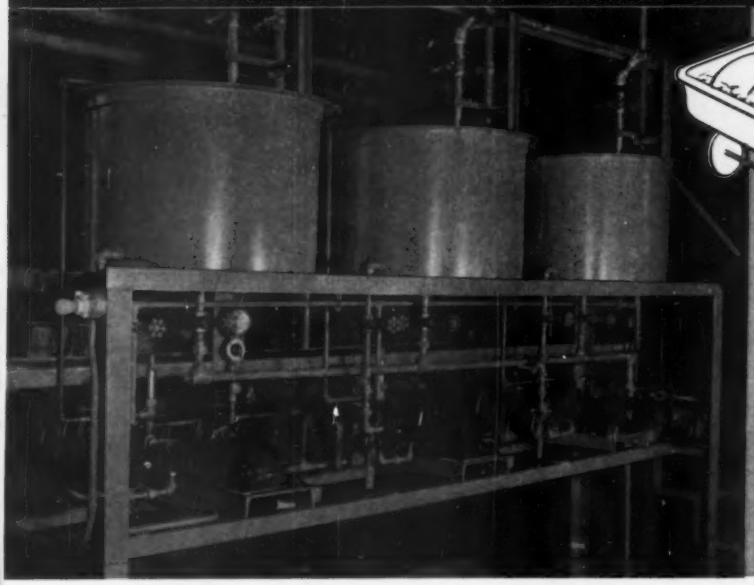
WATER FOR TRIPLE BOILERS INDIVIDUALLY TREATED BY SINGLE PACKAGE



Assembly includes 3 Model SHPM Adjust-O-Feeders—Capacity 7.8 GPH against 225 psig—handling phosphate and sulfite solutions.

This %Proportioneers, Inc.% packaged system includes metering pumps, chemical tanks, motor starters, controls, valves, piping, and all auxiliary equipment — compactly arranged as a single unit. Treating chemicals are fed automatically in proportion to service load on each boiler. This "Triplet Package" is supplied complete — a single responsibility for your chemical feeding system. We can also supply systems for treating one, two—or *any* number of boilers: chemical feeding systems for any power plant from the largest high pressure installation to the smallest low pressure job. For recommendations call in %Proportioneers, Inc.%.

Write for Brochure SM 9020
"Treatment of Water for Boilers" and Bulletin CAT.

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Write to %PROPORTIONEERS, INC.%, 385 Harris Ave., Providence 1, R. I.

Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

News

HERE'S THE INSIDE STORY ON SK EVAPORATORS

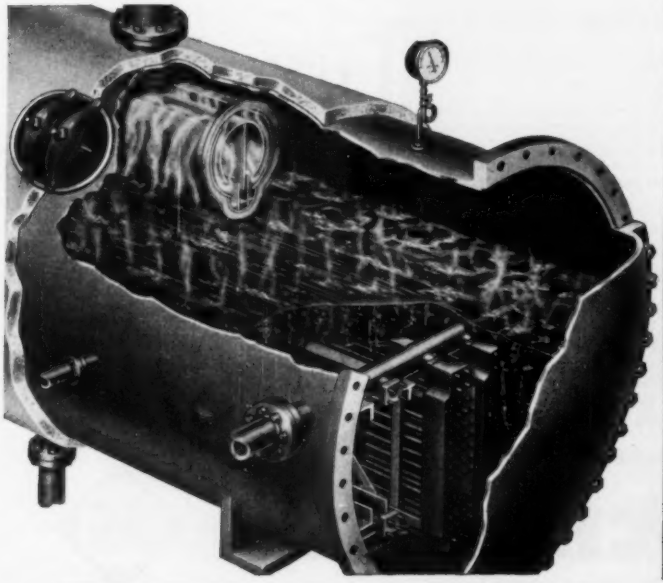
SK Evaporators of the type illustrated help reduce deterioration by providing distilled make-up water for modern boilers.

Designed and built, not to meet a price, but to provide sound engineering advantages, careful workmanship and A-1 materials with resultant *long range economy*, SK Evaporators offer real cost saving in operation and upkeep.

A look inside of this evaporator shows large liberating and tube surface areas which assure maximum heat transfer and high efficiency. The straight, special design, self-scaling tubes are mounted in easily removed bundles to facilitate maintenance and cleaning. A centrifugal separator, located inside the shell, prevents carry-over of moisture.

SK Evaporators are manufactured in various designs for stationary steam plants, for marine and other installations where the use of distilled water is desirable.

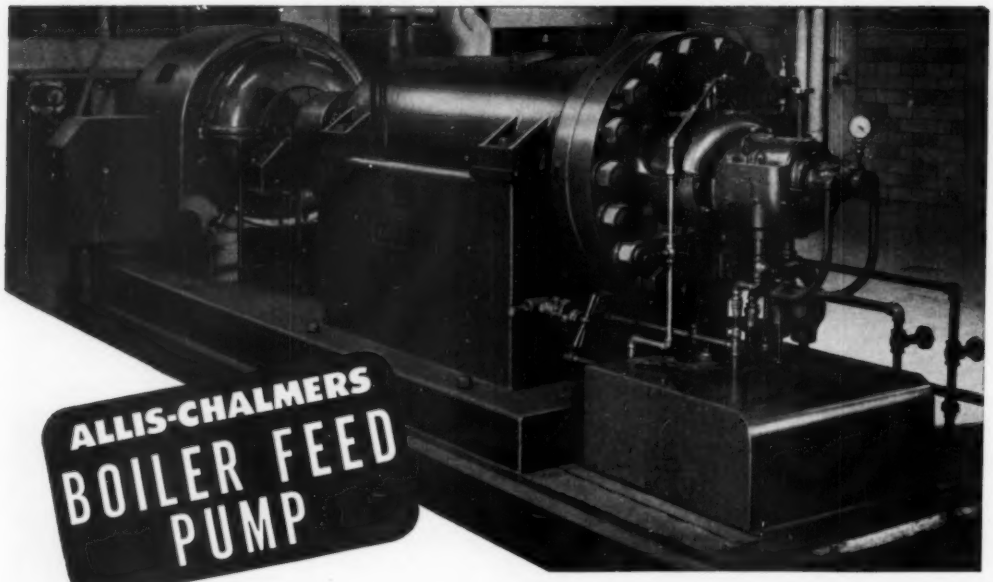
For engineering information on SK Evaporators, please write this company explaining your requirements.



The valve, illustrated, is one of four SK 12" Fig. 816XX high-pressure boiler Non-Return Valves recently installed in the power plant of a large utility in the St. Louis area. These valves are installed on boilers generating steam at 980 psi gauge and 915° F. and are used as stop valves to shut off flow from the boilers and as check valves to prevent backflow. They are constructed of Chrome Molybdenum Alloy Steel. All pressure castings were radiographed and magnetic particle inspected to assure best possible quality and freedom from defects.

Design features include: (1) Compact design requiring minimum headroom; (2) Pressure seal bonnet construction; (3) Free area, streamlined construction resulting in low pressure loss; and (4) Readily accessible parts for easy maintenance. These valves can be built for manual or motor operation.

Manufacturing Engineers



THESE 7 Features GIVE YOU RELIABILITY, LOW MAINTENANCE

1. Single stage, back-to-back impellers balance axial forces without use of balancing drum. Two impellers in first stage give advantages of double suction at this point.

2. Volute casing provides high efficiency and radial balance. Volute design also simplifies construction for easier maintenance.

3. Expansion joint is brought to outside of pump where leakage may be quickly detected and adjustments made without dismantling the pump. No flexible internal members are required for expansion compensation.

4. Packing is also located where it may be adjusted easily and quickly.

5. Uniform section of both inner and outer casings assures uniform expansion at all points. Expansion stresses are minimized; alignment is held.

6. Casing halves are held together with full hydraulic pressure of the pump assuring a tight seal with a minimum of heavy parts.

7. A carriage which may be attached to the pump body is furnished with each unit. The inner casing may be withdrawn from the outer casing on this carriage, making servicing easy and quick.

HERE IS A PUMP designed to meet the needs of the newer high pressure boiler plants. Efficiency is high, maintenance is low and every feature has a long record of successful application to boiler feed service.

Sizes range from 1200 to 2500 psig and from 300 to 2000 gpm. Allis-Chalmers can supply the complete boiler feed pump installation including pump, motor and control of coordinated design and manufacture.

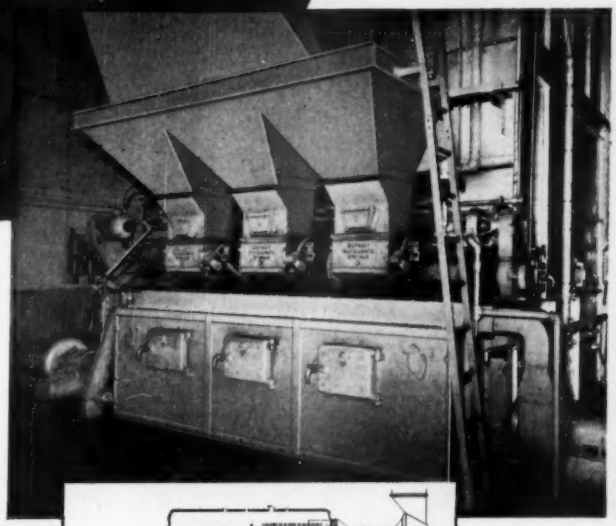
Get the details on this new boiler feed pump from your Allis-Chalmers District Office, or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-3407

ALLIS-CHALMERS

DETROIT ROTOGRATE

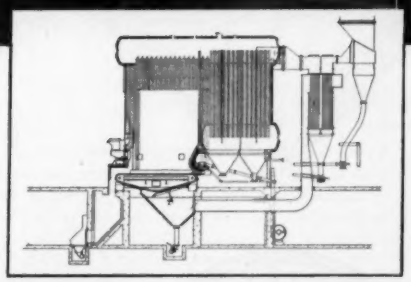
REDUCES COAL COST

Detroit RotoGrate Stoker with Erie City Type VL Boiler at Certain-teed Products Corporation, York, Pa. Capacity 45,000 pounds steam per hour. Operates with preheated air.



THIS Detroit RotoGrate Stoker fired unit has reduced fuel cost 12.6c per thousand pounds of steam at Certain-teed Products Corporation plant at York, Penna., according to report by Mr. W. M. Noon, Combustion Engineer. The reduction in steam cost was made at the same time plant capacity was increased.

The Detroit RotoGrate will save you money and improve your operation. It is the original spreader stoker with forward moving grates that discharge the ash at the front. It handles fluctuating as well as steady loads with high thermal efficiency. • You too can save money with Detroit Stokers. Write for Bulletin.



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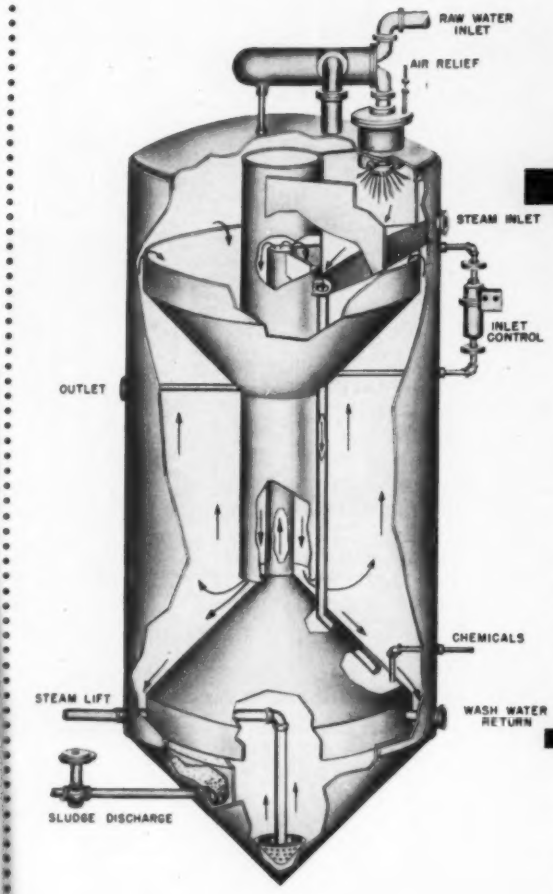
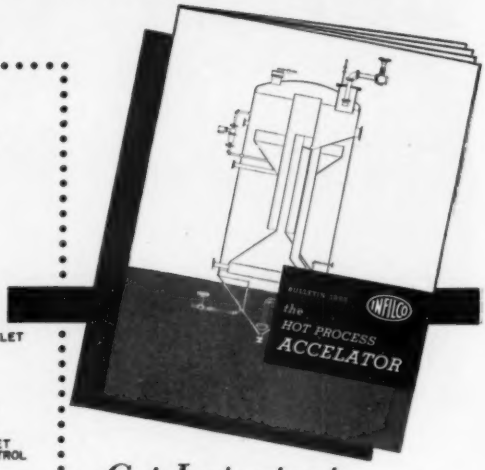
Now Ready... **bulletin 1855**

hot process water treatment





Get Important New Facts on:

1 Chemistry of boiler feedwater treatment
2 Hot Process softening and deaeration
3 Advantages and limitations
4 Accessory equipment
5 Typical installations (including drawings)

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Contains data based on 50 years' experience in softening and treating water.

HOT PROCESS

Accelator®

offers self-contained deaeration — controlled slurry recirculation — maximum silica reduction — chemical economy. Fully described in Bulletin 1855

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Special alloys lick special piping problems

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YOU can overcome special problems of corrosion, fluid contamination, pressure, or temperature by selecting pipe and welding fittings of special materials.

Tube Turns, Inc. continually studies the proper application of different materials to piping systems. The complete line of TUBE-TURN Welding Fittings is available in more than forty different alloys. Today's piping engineer can choose from intermediate and high alloy steels containing chromium, nickel, or both; commercially pure nickel, copper, and aluminum; and alloys of these.

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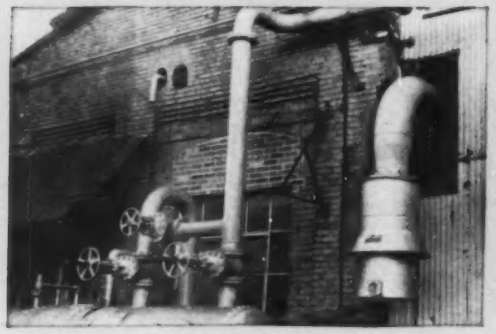
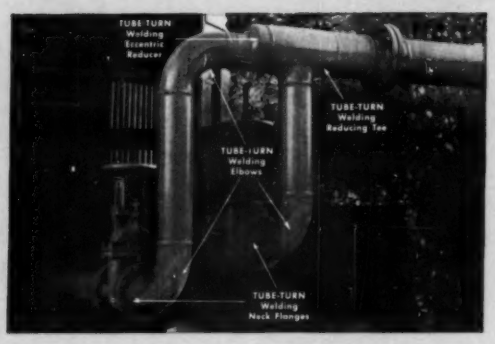
Piping construction simplified by wide range of TUBE-TURN Welding Fittings

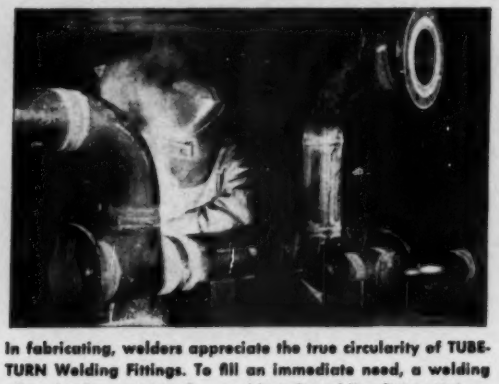


Welding complex process piping calls for a wide variety of fittings and flanges. In this installation, air is drawn into compressor through a 16-inch line, connected to an outdoor filter through a TUBE-TURN Welding Reducer. Air at 100 lbs. is piped to the compressor tank through an 8-inch welded line.



Manifold serves air lines to various shops. Matching the two 8-inch lines to the 12-inch line here was no problem. Use of a TUBE-TURN Reducing Outlet Tee and a TUBE-TURN Eccentric Reducer made the construction job easy. The main line can be opened easily at the TUBE-TURN Welding Flanges.

Small lines tap off fire foam chemical manifold, lead to storage areas and other critical locations. Leakage or weak joints here could be disastrous. Welded piping with strong TUBE-TURN Welding Fittings makes this fire protection reliable.



In fabricating, welders appreciate the true circularity of TUBE-TURN Welding Fittings. To fill an immediate need, a welding elbow is often cut to make an odd-angle welding fitting. Unique forging process assures that TUBE-TURN Welding Elbows can be cut at any angle and still match the pipe for proper welds.

TUBE TURNS, INC., Dept. C-8
224 East Broadway • Louisville 1, Kentucky

Your Name _____
Position _____
Company _____
Nature of Business _____
Address _____
City _____ *State* _____

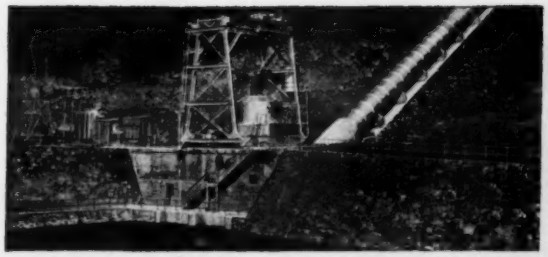
DISTRICT OFFICES

New York	Houston
Philadelphia	Tulsa
Pittsburgh	San Francisco
Chicago	Los Angeles

"tt" and "TUBE-TURN" Reg. U.S. Pat. Off.

TUBE TURNS, INC.

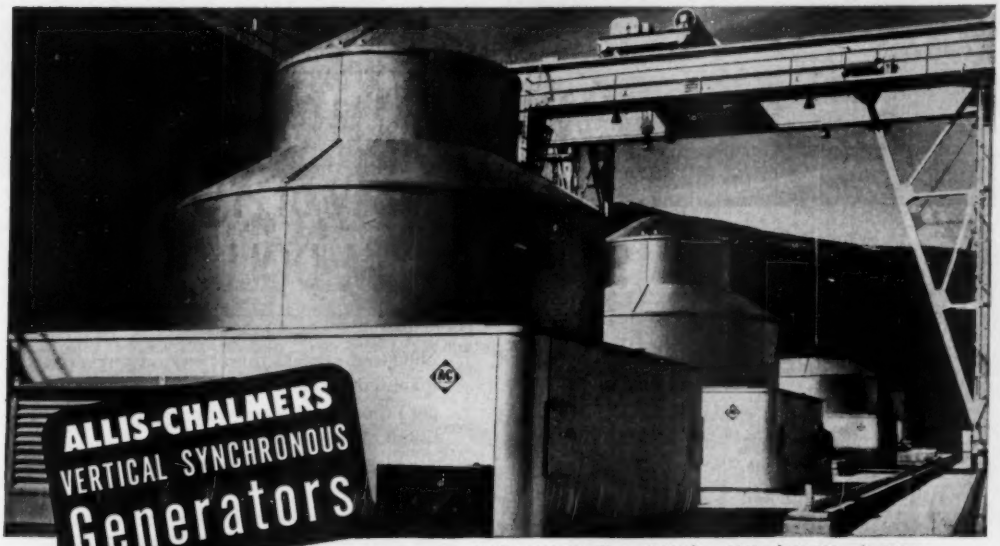
LOUISVILLE 1, KENTUCKY



UPPER MALAD: One 8400 kva, 85.7% pf, 6900 volt, 225 rpm generator. Also, A-C 12,000 hp, 124 ft head Francis-type turbine, station-service substation, switchgear, main power transformer.

LOWER MALAD: One 15,500 kva, 87% pf, 6900 volt, 200 rpm generator. Also, A-C 22,000 hp, 157 ft head Francis-type turbine.

All generators are modified umbrella type (with upper guide bearings) furnished complete with outdoor housings.



LOWER SALMON: Four 17,500 kva, 86% pf, 13,800 volt, 120 rpm generators — two arranged for variable-pitch propellers. Also, A-C 12,000 kva power transformer.

"OPERATION AND MAINTENANCE ... Very Satisfactory"

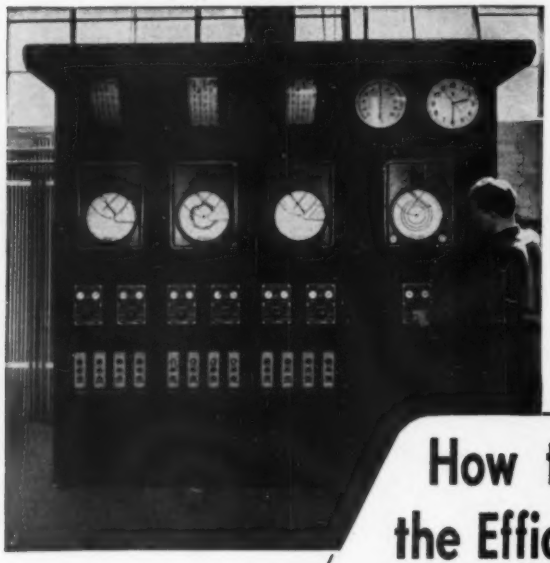
THAT'S the verdict of Mr. Lester Garlinghouse, plant superintendent of Idaho Power's new Lower Salmon, Upper Malad and Lower Malad stations. It's natural that the six Allis-Chalmers hydraulic-turbine-driven generators in these stations should be highly satisfactory: They are the result of more than 40 years' experience designing and building large generators.

Placed in operation in 1948 and 1949, these generators supply southern Idaho as part of the Northwest power pool. The Malad stations, which are remote-controlled from the Lower Salmon station, operate 24 hours a day, seven days a week. Lower Salmon is used for load factoring (peak load operation) and runs at full load an average of about 10 hours a day every day of the year.

Whatever your power requirements are, you can rely on Allis-Chalmers for efficient, reliable generators custom-engineered for your installation. Types, ratings and construction features are described in new bulletin 05B7549. Contact your A-C representative, or write Allis-Chalmers, Milwaukee 1, Wis.

A-3446

ALLIS-CHALMERS A-C ALLIS-CHALMERS



These Bailey Boiler Controls at the Chicago Pneumatic Tool Company's new plant in Utica, N. Y. insure efficient operation of three 25,000 lb per hour, 100 psi, spreader stoker-fired boilers

How to INCREASE the Efficiency of YOUR BOILER-ROOM DOLLAR

Before you get steam you've got to spend dollars—so dollars are a form of energy.

And if your boiler-room dollars are invested in equipment that isn't working efficiently, economically, your "investment" is poor.

That's where co-ordinated controls by Bailey can help. Here's why they'll increase your "boiler-room investment efficiency":

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service—conveniently located near you.** Bailey Meter Company's sales-service engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

•

For better "boiler-room investment" efficiency—for more power per fuel dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

A-111-0

BAILEY METERS

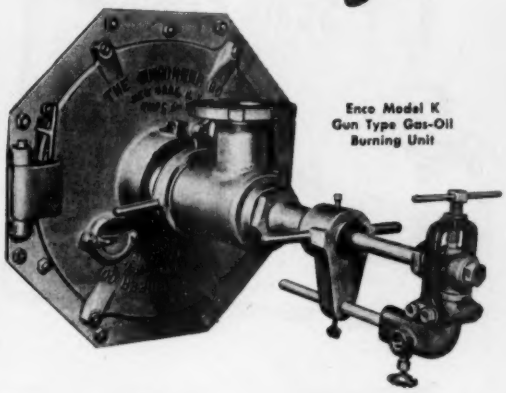
BAILEY METER COMPANY

1040 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls for Steam Plants
COMBUSTION · FEED WATER
TEMPERATURE · PRESSURE
LIQUID LEVEL · FEED PUMPS

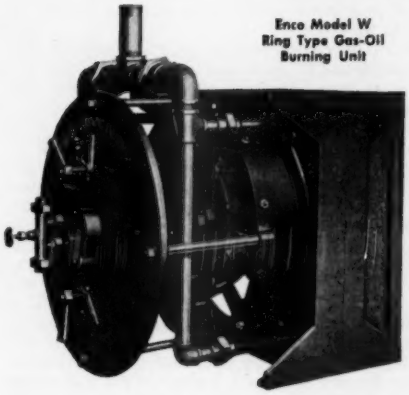
flexible... 3 ways

ENCO
OIL AND GAS BURNER UNITS



Enco Model K
Gun Type Gas-Oil
Burning Unit

These specially designed oil and gas burner units fit your needs . . . even when your operating conditions keep changing. Enco Oil and Gas Burner Units offer money-saving flexibility on three important counts. (1) They are designed for use with either oil or gas — or both . (2) They assure completely uniform combustion and greater fuel economy though steam demands swing sharply. (3) They can be operated by either natural or forced draft.



Enco Model W
Ring Type Gas-Oil
Burning Unit

Even if your old combustion equipment "works", it pays to investigate the fuel-saving economies and full flexibility of these highly efficient units. Enco Burner Units are made in many sizes to suit all capacity requirements. Bulletin on request.

ENCO
INTERCHANGEABLE ATOMIZERS
FOR USE WITH ALL TYPES OF BURNER EQUIPMENT

Wide Range Mechanical—Manual or automatic control. Constant high oil pressure at atomizer insures efficient atomization over entire load range without recirculating or returning oil.

Steam or Air—Wide range. Controlled by manual or automatic pressure regulation.

Standard Range Mechanical — Available in all sizes to suit load and capacity requirements.

Enco Standard Range Mechanical Atomizer Gun

Enco Wide Range Steam Atomizer Gun

Enco Wide Range Mechanical Atomizer Gun

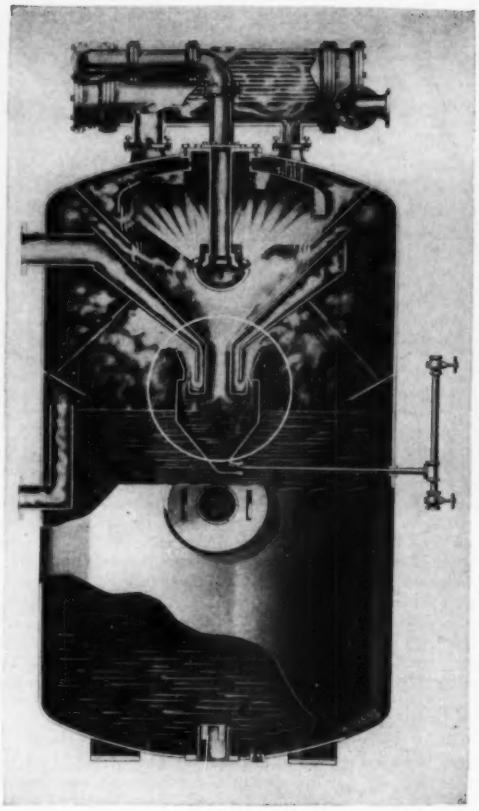
Enco Standard Atomizer Gun Support

Enco Gas Burning Gun

EC-482

THE ENGINEER COMPANY 75 WEST STREET, NEW YORK 6, NEW YORK

IN CANADA: F. J. BARKIN, LTD., 4250 IBERVILLE ST., MONTREAL 34 P.Q.



Hard scale, formed on the trays of deaerating evaporator preheaters, is no longer the big problem it used to be.

In a large central station (name on request), the preheaters had to be cleaned every three weeks, and the units were completely shut down at that time from eight to ten hours.

Then Worthington steam-jet deaerators were installed—with a "blowdown" head designed by Worthington engineers. This special head allows the operator to remove harmful deposits at regular intervals *while the unit continues in service*. It also provides for simple and speedy acid cleaning of critical parts, when necessary, without even opening an access door or removing any parts from the unit.

• Compare The "Time-Outs"

The Worthington unit, given a short blowdown once each shift, stays in continuous operation with maximum deaeration for periods of at least 8 months. When the acid treatment is given at the end of that period, the job is finished in under three hours.

Compare this with the former record. *Then*—8 to 10 hours outage every three weeks and labor by a *crew* of men. Now—with Worthington's blowdown head—operation uninterrupted during regular short blowdown, with a shutdown for acid cleaning only once in almost a year, requiring only one man and three hours!

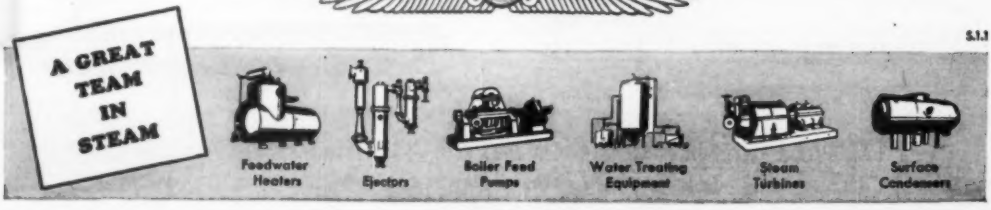
Worthington Makes Deaerating Equipment News

Developments like this, applicable to any deaerators operating under conditions of scaling, are typical of Worthington's engineering firsts in water treating and deaerating equipment.

Worthington manufactures all of the equipment needed in a complete water treating installation. For further information on why *there's more worth in Worthington*, address Worthington Pump and Machinery Corporation, Steam Power Div., Harrison, N.J.

WORTHINGTON

S.1.1



Carbon, Alloy and Stainless steel tubes are defined under CMP regulations as "controlled materials". As such, they are critical materials. Not being a mind reader, "Mr. Tubes"—your B&W Tube Company representative—needs a *close* look at the following facts in order to supply the available tubing most economically suited to your requirements.

1 All related CMP authorizations and government contract numbers.

2 Any acceptable alternates in type, finish, composition, and size.

3 A brief, informative description of your intended fabricating methods.

4 A description of the end-use, exact as to product and its service.

THE BABCOCK & WILCOX TUBE COMPANY

Executive Offices: Beaver Falls, Pa.

General Offices and Plants

Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio—Welded Carbon Steel Tubing

Sales Offices: Beaver Falls, Pa. • Boston 16, Mass. • Chicago 3, Ill.
Cleveland 14, Ohio • Denver 1, Colo. • Detroit 26, Mich.
Houston 2, Texas • Los Angeles 15, Calif. • New York 16, N. Y.
Philadelphia 2, Pa. • St. Louis 1, Mo. • San Francisco 3, Calif.
Syracuse 2, N. Y. • Toronto, Ontario • Tulsa 3, Okla.

B&W SEAMLESS and WELDED TUBES

TA-1640-G

MAMMOTH *of the* MISSISSIPPI

Venice No. 2 Steam Power Station, Venice, Illinois

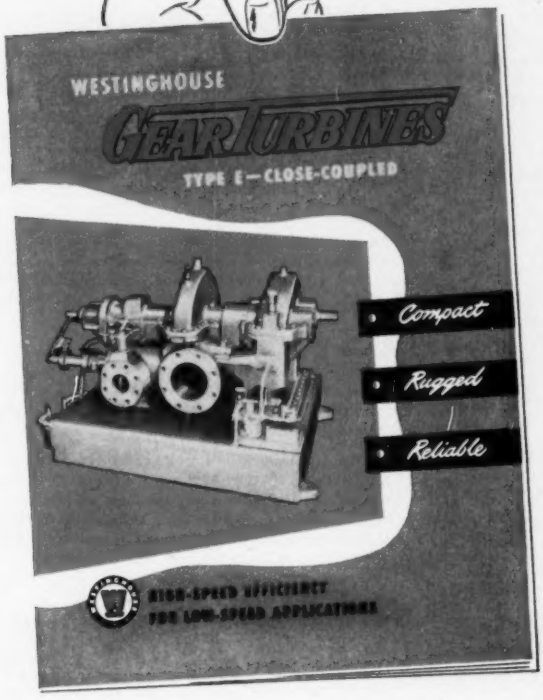
Following a report on the industrial power needs of the Union Electric Power Company area made by Stone & Webster Engineering Corporation, we were retained to design and construct this 400,000 kw Steam Power Station. The station, located at Venice, Illinois, on the banks of the Mississippi River, has established an outstanding record for efficiency and reliability.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

A gearturbine built to save...

Three ways



The Westinghouse Gearturbine costs less to buy . . . less to install . . . and less to maintain. Wrapped up in a single package is a compact, rugged and reliable speed-reduction unit solidly coupled to a Type E turbine. It's the ideal combination for ratings up to 500 hp and output speeds commonly found in single-ended applications.

Here's economy made possible by a standardized design that cuts manufacturing costs . . . avoids costly specials . . . saves space . . . and simplifies maintenance. And you get the maximum flexibility possible . . . any combination of three turbine wheel sizes, three gears and three types of governor can be used according to your needs.

Other plus features are . . . solid coupling of turbine shaft to pinion shaft; single-helical gearing; forced circulation, filtered oil; and 3-point support for easy mounting and leveling.

J-50521

GET THE FULL STORY. A newly available booklet, B-4346, clearly explains the applications, refinements and advantages of Westinghouse Gearturbines. Ask your nearby Westinghouse representative for your copy, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

YOU CAN BE SURE... IF IT'S
Westinghouse
TYPE E Turbines

"K" MONEL and "KR" MONEL

Age-hardenable, non-magnetic alloys offering high strength, excellent corrosion-resistance and good working properties

Where stressed structural members must be placed close to sensitive electro-magnetic equipment, or where extra strength is needed in corrosive environments, these Inco Nickel Alloys offer solutions to the problems of metal selection.

Both alloys show *improved* strength and hardness at sub-zero temperatures. And both alloys provide moderate strength at temperatures to 900°F.

"K"® Monel and "KR"® Monel are similar in composition and properties. "KR" Monel has better machinability and is recommended for parts requiring intricate machining.

The principal engineering characteristics of these alloys are:

Tensile Properties: "K" Monel in the fully age-hardened condition has a minimum yield strength (0.2% offset) of 100,000 psi and a tensile strength of over 140,000 psi, with minimum elongations (in 2 in.) of 15% and 20% for cold-drawn and hot-rolled materials respectively. "KR" Monel, age-hardened, has a minimum yield strength (0.2% offset) of 90,000 psi with minimum elongation of 20% (in 2 in.) for as-rolled material.

Shear Strength: The shear strength of "K" Monel, as determined with .050-in. x .250-in. specimens subjected to double shear, is (full hard, age-hardened) 98,450 psi maximum, with 0.04 in. deflection. The shear strength of "K" Monel rivets, fully age-hardened, is 89,200 psi with ultimate tensile strength of 147,000 psi.

Spring Properties: "K" Monel wire can be cold-drawn and age-hardened to develop 160,000 to 200,000 psi tensile strength. The torsional proportional limit of cold-drawn, age-hardened wire is about 40% of the ultimate tensile strength.

Endurance Limit: In rotating beam tests of polished specimens at room temperature and 10,000 r.p.m., "K" Monel (cold-drawn, age-hardened) showed an endurance limit for 10^8 cycles of 41,000 to 59,000 psi.

Magnetic Characteristics: "K" and "KR" are non-magnetic under ordinary conditions and remain so at sub-zero temperatures.

Working Characteristics: Both "K" Monel and "KR" Monel may be hot-worked, forged, and cold-worked. "K" Monel may be readily machined in the annealed condition and may be considered commercially machinable at practical rates in other conditions with Brinell hardness of up to 275. "KR" Monel, because of higher carbon content and special thermal treatment, has better machinability than "K" Monel and is recommended for parts requiring more intricate machining. Because of greater hardness, both alloys will take a higher polish than Monel. Both may be joined by the usual welding, brazing, and soldering processes.

Corrosion Resistance: These alloys are highly resistant to attack by most commonly-encountered corrosives, including mineral and organic acids, alkalies, salts, potable and industrial waters, foods, organic compounds, and oxidizing atmospheres at normal and elevated temperatures.

Forms Produced: "K" Monel is supplied in most commonly-used mill forms—rods, hexagons, squares, flats, strip, sheet, seamless tubing, wire, welding materials—and in a variety of finishes and conditions. "KR" Monel is produced in rods, hexagons, squares, hot-rolled and cold-drawn.

Applications: Because these alloys retain their non-magnetic, corrosion-resistant, and high physical qualities at abnormal temperatures, they have been used to advantage in aviation instruments, roller chains for retractable landing gear, controls, springs and contact arms in electrical equipment, in stressed structural members and fastenings.

"K" MONEL
Effect of temperature on physical properties
(Age-hardened condition)

Test Temperature °F.	Yield Strength (0.20% offset) psi.	Tensile Strength psi.	Elongation in 2 in. per cent	Creep Strength (0.10% in 10,000 hr.) psi.	Hardness (Brinell)	Impact (Charpy) ft.-lb.
−300	160,200	202,000	27	...	...	...
−110	134,600	171,550	17.3	...	36 (Rock. C)	27
Room	111,000	160,000	23.5	...	331	27
200	108,000	150,000	23.5	...	...	...
400	103,000	149,000	24	...	...	...
600	105,000	146,000	23	...	...	...
750	...	...	...	67,000	...	...
800	105,000	124,000	8.5	48,000	302	...
1000	92,000	95,000	3	8,500	255	...
1100	...	...	...	...	229	...
1200	80,000	80,000	1.5	...	...	...
1400	30,000	45,000	8	...	...	...

FURTHER DATA AVAILABLE

A 23-page reference manual, *Engineering Properties of "K" Monel and "KR" Monel*, contains all essential engineering information on these alloys. It is available, free, for your files.

Nickel alloys are being increasingly diverted to defense applications. However, technical help for metal problems involving corrosion, high temperatures or fatigue is available from INCO's Technical Service, either for immediate defense needs or for future installations.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

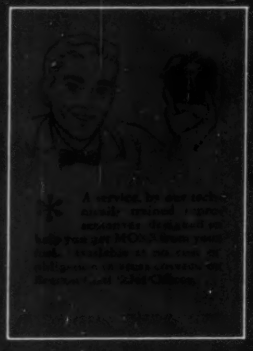
EMBLEM OF SERVICE
NICKEL INCO ALLOYS

burning

too much

money?

perhaps **Beacon Combustion Service**



EASTERN GAS AND FUEL ASSOCIATES

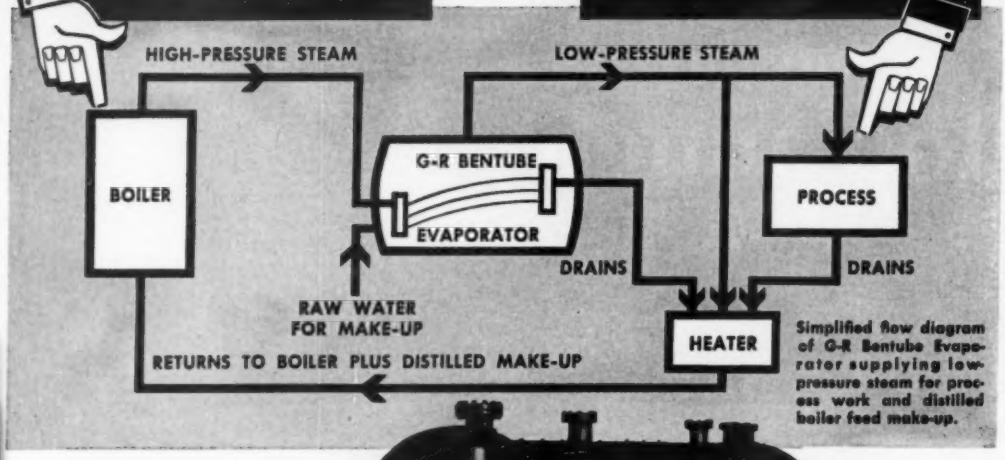
PITTSBURGH BOSTON CHICAGO CLEVELAND DETROIT NEW YORK

NORFOLK PHILADELPHIA SYRACUSE

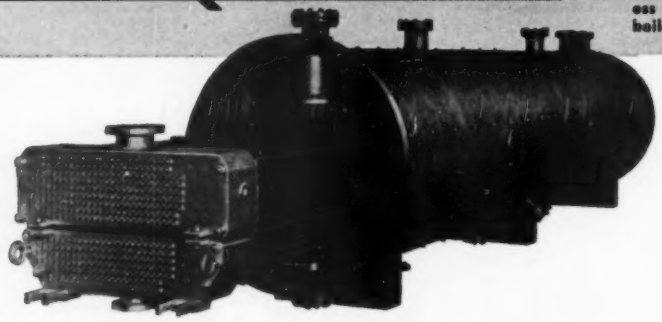
For New England: New England Coal & Coke Co., *For Export:* Castner, Curran & Bullitt, Inc.

with a G-R Bentube Evaporator

PURE WATER for Boiler Feed Make-Up *plus* **STEAM for Process Work**



Simplified flow diagram of G-R Bentube Evaporator supplying low-pressure steam for process work and distilled boiler feed make-up.



This two-in-one unit can double as a 100% thermally efficient reducing valve and raw water purifier. Part of the vapor which it produces can be used as low-pressure steam for process work, while the remainder is condensed as distilled water for boiler feed make-up. The G-R "Reducing Valve" Evaporator wastes no heat . . . requires no chemicals.

For more than 50 years, G-R Evaporators have been proving their effectiveness and economy in marine and stationary installations, large and small. Today, they are in use in power generating stations, industrial and process plants all over the country, as well as on many hundreds of naval and merchant marine vessels . . . wherever pure water is a necessity.

The exclusive features and distinctive advantages of G-R Bentube Evaporators include their famous scale-shedding Bentube elements, design provisions for pure vapor, thorough drainage and easy accessibility.

Write for Bulletin describing these units in detail.

THE GRISCOM-RUSSELL CO., 285 MADISON AVE., NEW YORK 17, N. Y.

GR-285

GRISCOM-RUSSELL

PIONEERS IN HEAT TRANSFER APPARATUS

What Time This Month Will Boiler Tube Deposits Shut Down Your Plant?

It can happen *any day . . . any minute.* Deposits may be forming in your boiler tubes *right now* . . . adding layer on layer . . . building up for the failure that is sure to come!

When it does come, you can be sure of one thing. It's going to be expensive! Not only will replacement and installation costs be higher, but you'll also lose valuable production time. And unless your deposit problems are solved, it can happen again and again!

Drew Water Treatment will prevent the formation of deposits. Drew Service protects boilers and power plant equipment with a 3-point program that works! Here's what it does:

1. Drew engineers make a thorough study of plant operations and water problems.
2. Drew water chemists and engineers analyze this data in the modern Drew Laboratories and make specific recommendations for treatment.
3. Drew engineers make periodic service calls at your plant to insure the efficient and economical performance of your water conditioning.

Thoroughness of investigation, proper treatment and frequent service have made Drew one of America's fastest growing water treatment companies. Industry's most respected names avail themselves of Drew Boiler Water Treatment and Service. Do the same. Consult the nearest Drew engineer or write for information.

Send for new illustrated DREW ORGANICS folder describing the use of organics in modern boiler water treatment. Write today

POWER DREW CHEMICALS

Power Chemicals Division

E. F. DREW & CO., INC.

15 East 26th Street, New York 10, N. Y.

DREW PRODUCTS

Nationwide Service in Boiler Water and Cooling Water Conditioning

Do you have boiler like these?

	To recondition or add new boiler To get better process load regulation	To get better efficiency. To get more out of boiler due to rising load
	AMERICAN TOBACCO COMPANY	RAYBESTOS-MANHATTAN COMPANY
BOILERS	Three (one stand-by)	Four
RATING	16,500 lb per hr	19,650 lb per hr
LOAD SWINGS	Total fluctuation up to 20,000 lb per hr	Moderate load swings
FUEL	Coal	Coal
STEAM USE	Power and process	Process pumps, compressors and heating
results	"The Hays instruments and controls through greater efficiency . . . gave us the solution . . . that of increasing steam capacity and accurate automatic control of the load."	"Our basic reason for installing the Hays Control was to obtain better efficiencies. Our aim was more than reached . . . efficiency . . . 79.3%."

Here are 8 "case histories" telling how leading companies solved their boiler plant problems. You'll note that there are small boilers and large boilers—all types of fuels, including alternate fuels—different load characteristics—and different uses for steam.

The two things all these plants have in common are HAYS COMBUSTION CONTROL and a record of continuing excellent results—top efficiencies, greater capacity, high CO_2, reduced fuel, labor and maintenance expense, etc.

In each boiler plant, Hays instruments and control were tailored to the specific conditions and requirements . . . "packaged" in a handsome panel . . . and engineered for the results desired.

Here's how to find out the details which can help you in solving your boiler plant problems. Select the "case history" which is close to your conditions and requirements—and then check the attached coupon. You'll get complete factual details of the boilers and related equipment, load characteristics, fuels, and fuel handling, as well as an explanation of the operation of the control system complete with schematic drawings.

get these factual

RESULTS STORIES

American Tobacco Co.

Raybestos-Manhattan Co.

THE **HAYS** CORPORATION
MICHIGAN CITY 7, INDIANA

Automatic Combustion Control • Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol • Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders • Electronic Oxygen Recorders

plant problems

To make possible easy future expansion with maximum fuel flexibility	To lower operating costs while handling load fluctuations	To modernize plant and to increase boiler plant efficiency	To get accurate control of pulverized coal and oil firing through load swings	To meet varied manufacturing demands and to achieve savings in fuel and labor	To get greater capacity while operating at top efficiency
A. B. DICK COMPANY	**SUNSHINE BISCUIT COMPANY**	**FALSTAFF BREWING CORPORATION**	**BEMIS BROS. BAG COMPANY**	**BALDWIN LOCOMOTIVE WORKS**	**SCOVILL MFG. CO.**
Three	One, plus steam generator incinerator	One	Two	Three	Two
25,000 lb per hr each	31,500 lb per hr	48,000 lb per hr	70,000 lb per hr and 80,000 lb per hr	160,000 lb per hr	One 225,000 lb per hr One 150,000 lb per hr
5—10,000 lb per hr fluctuation without warning	Daily variation 20,000 lb per hr	Fluctuates 12,000 to 28,000 lb per hr	Daily variation 15,000 lb per hr	Intermittent, no warning swings up to 100,000 lb per hr	Load swings up to 60,000-70,000 lb per hr
Coal or gas	Oil	Coal	Oil and coal	Coal and oil	Coal and oil
Heating and process	Process	Heating and process	Power, process and heating	Heating and process	Power, heating and process
"Because of its simplicity (Hays Combustion Control) has enabled us to change quickly from coal to gas firing . . . aided us to achieve 73% efficiency rating in winter—71% in summer."	"Our management and operating crew are well pleased with the new (Hays) unit . . . low maintenance costs . . . equipment enables us to keep close watch over our operating costs."	"Our boiler is operating at 82% efficiency and our maintenance expense bill has been cut 65% . . . our fuel bill has decreased by several hundred dollars per month."	"We have made test runs using the Hays Automatic Combustion Control System, bringing the load rapidly up from 8,000 lb per hr to 80,000 lb per hr with excellent results."	"Our Hays Combustion Control System has aided us substantially in cutting our fuel, labor, and maintenance expense . . . saved 30,000 tons of coal per year . . . we operate with 42 less men than were formerly used."	"We are meeting steam demands up to 400,000 lb per hr achieving an evaporation rate of 12.8, a fuel cost per kw of $.0049, and a cost per 1,000 lb of steam of $.706."

A. B. Dick Company

Sunshine Biscuit Co.

Falstaff Brewing Corp.

Bemis Bros. Bag Co.

Baldwin Locomotive Works

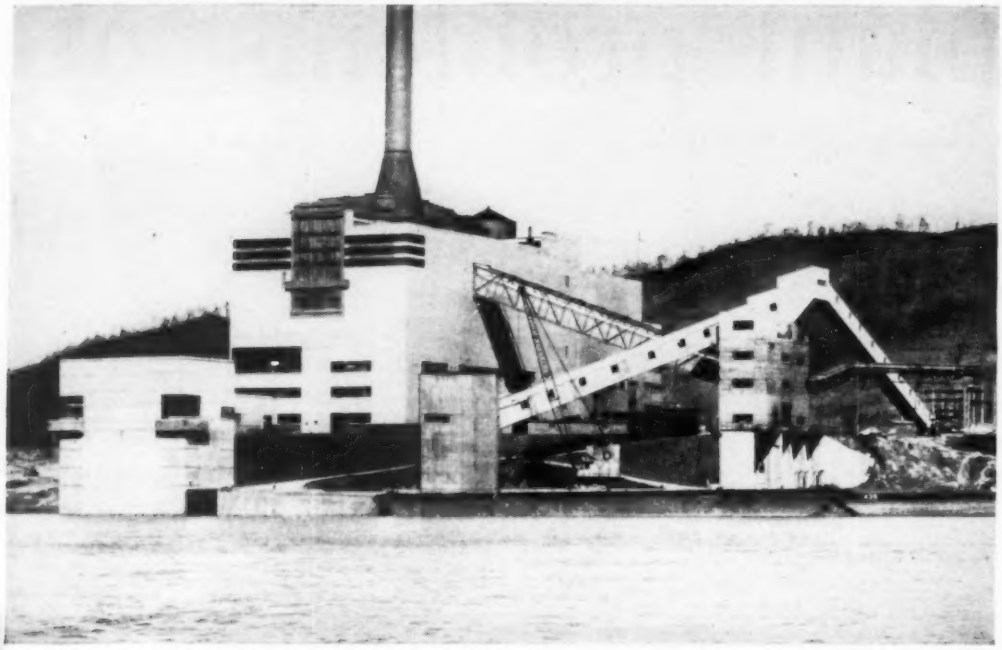
Scovill Mfg. Co.

The Hays Corporation, Michigan City 7, Indiana
I've checked the RESULT STORY(S) that cover the conditions in my plant. Please send it immediately.

- ☐ American Tobacco Co.
- ☐ A. B. Dick Company
- ☐ Falstaff Brewing Corp.
- ☐ Baldwin Locomotive Works
- ☐ Raybestos-Manhattan Co.
- ☐ Sunshine Biscuit Co.
- ☐ Bemis Bros. Bag Co.
- ☐ Scovill Mfg. Co.

Name_____ Address_____

Title_____ City & State_____



Unique Circulating Water System Installed in This Power Plant

The R. E. Burger steam-electric plant of Ohio Edison Company is located on the Ohio River well above flood stage—which may reach as much as 60 feet above extreme low water. Water is supplied to the condensers by a patented circulating water system pioneered jointly by Worthington and the consulting engineer, Mr. George W. Saathoff.

All major equipment except circulating pumps, which are designed to operate completely submerged if necessary, are located above flood stage.

The new installation of a Worthington 70,000 sq ft two-pass condenser and auxiliaries, serving a 90,000 kw turbine-generator, is the third Worthington unit in this station. Two 46,000 sq ft condensers were previously installed.

For advice on any new installation or information on a wide range of power plant equipment, consult Worthington Pump and Machinery Corporation, Steam Power Division, Harrison, New Jersey.

HOW IT WORKS

Two full-capacity circulating pumps are used in series.* The primary pump, submerged below extreme low water, is a Worthington motor-driven HIFLO. Its high starting head characteristic is able to deliver enough water for starting purposes. A booster pump—a single-suction volute Worthington MIXFLO, mounted directly upon an hydraulic turbine—starts when there is enough water in the control well. The two pumps then operate automatically in series at full capacity.

Advantage is taken of maximum siphon effect from the condenser drop leg which enters the sealing or control well. From this well, all circulating water is passed through the hydraulic turbine. Thus the static head from sealing well to river level is utilized—75-80% being recovered—in reducing the work of the primary pump, with saving in overall pumping power.

The booster pump functions until rising water renders the turbine ineffective. Then the primary HIFLO works alone, producing full capacity under reduced head.

*In the new unit, there are two half-capacity primary pumps, permitting operation of only one in the winter when low water temperatures prevail.

Z.1.1

WORTHINGTON

WORLD'S BROADEST LINE OF STEAM POWER PLANT AUXILIARIES

Feed Water Heaters · Boiler Feed Pumps · Steam Turbines
Steam-Jet Ejectors · Water Treating Equipment · Surface Condensers

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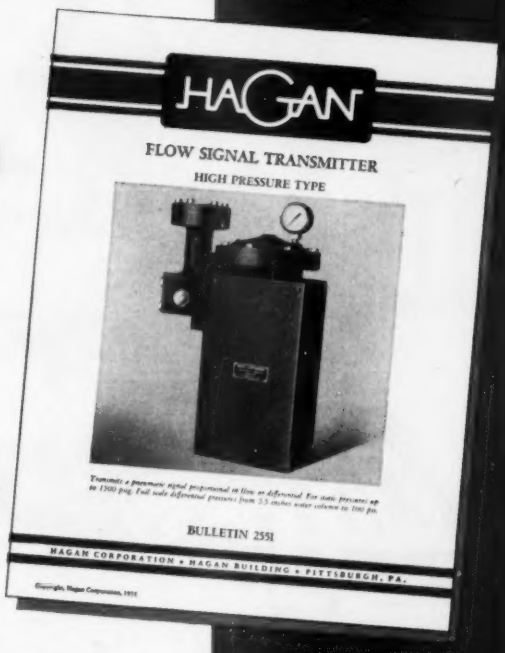
HAGAN

Flow Signal Transmitter

Measures pressure or flow and transmits a proportional pneumatic signal to recording or control instruments



The Hagan Flow Signal Transmitter is a pneumatically operated sender which transmits signals in a definite relation to a measured pressure differential.

Applications include measurement of gas, vapor or liquid flow, measurement of liquid levels or absolute pressures. Differentials at full scale can run from 5" water column to 100 psi, at static pressures up to 1500 psig.

Write for Bulletin 2551, which contains details of construction and performance of the Hagan Flow Signal Transmitter. Address: Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

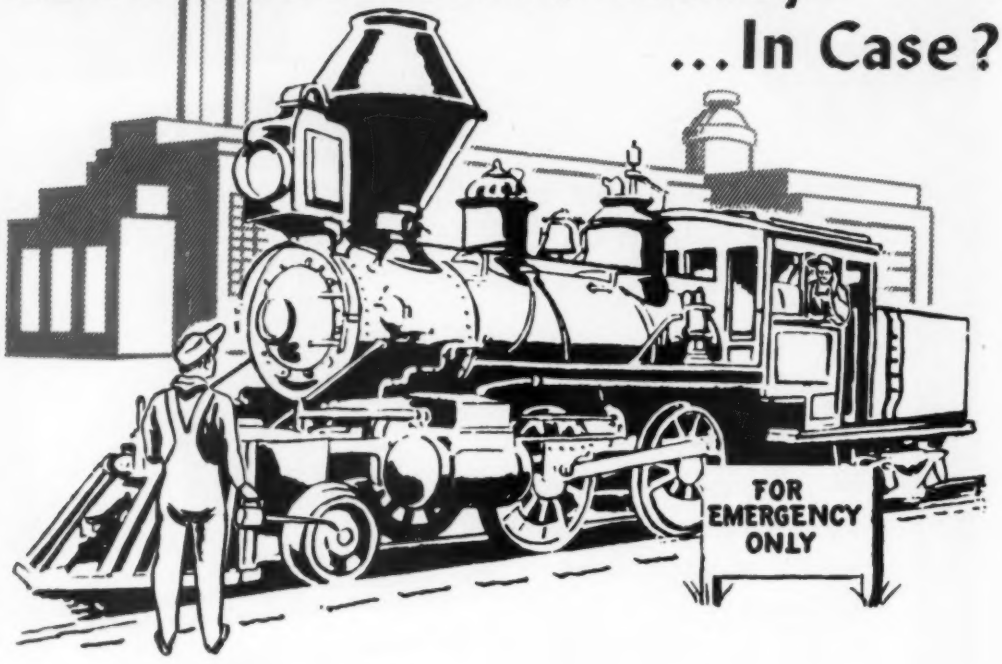
HAGAN

HAGAN CORPORATION
HAGAN BUILDING, PITTSBURGH 30, PA.

RING BALANCE HAGAN *Ring Balance*

combustion control systems . . . ring balance flow and pressure instruments

Got a Locomotive Handy ...In Case?



EVERY so often a steam locomotive makes news by going to the rescue of a plant where the steam system gave out at a critical time.

This is one answer to continued steam production pending repairs... and undoubtedly an expensive one. Simplest—and most economical—is to use the Nalco System and eliminate the chances of boiler down time due to faulty water treatment.

Nalco chemicals and services aim at *water treatment results* from raw water intake to condensate hot well . . . And the thousands of plants now using the Nalco System testify to the accuracy of this aim during the past twenty-six years. Whether your plant is large or small; your water problems scale, corrosion, carry-over—or just plain high cost—unless you have a locomotive handy for emergencies, better check with Nalco today. No obligation... and an excellent chance for permanent water treatment security.

P. S. More steam locomotives use Nalco-treated water than any other kind . . . Perhaps the reason why locomotives *can* be of help in plant emergencies!

NATIONAL ALUMINATE CORPORATION

6224 West 66th Place • Chicago 38, Illinois

Canadian inquiries should be addressed to
Alchem Limited, Burlington, Ontario, Canada

THE *Nalco* SYSTEM... Serving Industry through Practical Applied Science

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

ELECTRICAL

101 More Power from Your Batteries — Eight-pp Form GB-1309 presents company's plan for conserving and extending battery power, under which battery performance can be substantially increased. The plan is a complete and integrated system of manuals, articles, specifications, bulletins, charts and record cards which explain how to select, charge and handle, maintain and determine condition of batteries. Industrial Div., Gould-National Batteries, Inc.

102 Fan-Cooled Motors — Bulletin 05B7150A, 6 pp, describes types of construction and ratings of company's improved totally-enclosed, fan-cooled motors with tube-type, air-to-air heat exchangers. Includes chart showing ratings of these motors in squirrel-cage, wound-rotor and synchronous types for both horisontal and vertical installation. Explains that these motors can be modified to be made explosion proof, or supplied with construction of metals resistant to particular atmospheric acids or alkalies. Allis-Chalmers Mfg. Co.

103 Motor Selection — Bulletin G51-1 presents briefly manufacturer's line of motors, describing and illustrating single-phase, polyphase, and squirrel cage models. Gives ratings, uses. Wagner Electric Corp.

104 Safety Wiring — This informative 44-pp book presents a self-contained wiring system in which conductors are spaced and insulated by a non-combustible mineral insulation encased within a flexible seamless metallic tube. Stresses its safety advantages, also high frequency conductor characteristics. A discussion of the wiring from an engineering viewpoint includes construction and performance characteristics. The wiring size reference system is explained, sizes listed and recommended applications given. Excellent installation instructions are provided. Thoroughly illustrated with photos and drawings, includes a master chart for fittings. General Cable Corp.

105 Data on Transformers — Bulletin 8-501-B offers 32 pp of ordering and engineering information on current, potential and metering transformers. It's packed with technical data in the form of detailed drawings, accuracy limits, ratio and phase angle curves. Well illustrated, indexed, punched for filing in ring binder. The Standard Transformer Co.

106 Carbon Brushes for Electric Equipment — Publication GEA-5507, 28 pp, explains and illustrates fundamental considerations given to design, application and manufacture of carbon brushes and includes section on brush terminology. Produced to familiarize users with physical characteristics that must be known before proper recommendation can be made for a brush application, booklet also tells of company's engineering services. Includes sections on types of brushes, characteristics of brush grades, grade recommendations, tips of brush replacement. General Electric Co.

107 Co-ordinated Protection of Motors — The interlinked protection of circuits, motors and personnel is explained in 12-pp Bulletin DB-4673 on high-voltage combination starters. Because almost every 2300/4800 v power system can produce high currents under short-circuit conditions, booklet stresses this interlinked protection, covering three classes of combination motor starters: an air-break type for squirrel-cage induction motors; a starter with oil-immersed contractor, and a combination synchronous motor starter. The fuse used in each starter is described as to its fault-protecting abilities. Comparative discussions of contractor types are provided to facilitate selection. Westinghouse Electric Corp.

108 Automatic Voltage Regulators — Twelve-pp Bulletin 8351 details the workings of company's regulators in maintaining a constant output voltage regardless of fluctuations in a-c input line voltages and changes in output load. Standard models of both instantaneous electronic and electro-mechanical types are discussed. Includes outline drawings and performance data, also complete rating chart for selecting the right unit for a specific application. The Superior Electric Co.

109 Electricity as Required — This 16-pp booklet illustrates wide usage of manufacturer's diesel electric sets on various power applications. Briefly outlines specifications of models from 21 to 314 kw. A special chart for self-regulated and externally-regulated sets is also featured. Additional information covers attachments, simplicity of construction, portability, performance characteristics. Caterpillar Tractor Co.

110 Tables at Your Fingertips — Booklet B 3677-A is small enough for your vest pocket but its 56-pp are crammed with tables, formulas and other data of value not only in electrical maintenance but in other applications as well. Electrical information covers everything from brief definitions of common terms to first aid measures for electrical accidents. Includes wire and conduit sizes, formulas for determining amperes, kilowatts and kva, power factor correction, voltage drop tables, wire calculations, full load current of motors, explanations of graphical symbols, other useful data. Westinghouse Electric Corp.

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PUMPS

111 Boiler Feed Pump — A barrel-type boiler feed pump for high pressure, high temperature service and designed to go on the line quickly without preliminary warm-up, is the subject of 12-pp Bulletin 1525. Fully illustrated text explains automatic operation of hydraulic thrust balance incorporated in this pump. Impellers, diaphragms, bearings and stuffing boxes are described, ease of servicing discussed. De-Laval Steam Turbine Co.

112 Vertical Sump Pumps — Modern features of design and construction in company's new line of vertical sump pumps are discussed and illustrated in Bulletin 4600A, 8 pp. Provides construction illustrations, selection tables and specifications. The Deming Co.

113 Self-Priming Pumps — A new line of self-priming centrifugal pumps in capacities from 4000 to 90,000 gph are introduced in Bulletin 51–27, 20 pp. Describes and illustrates their simplicity of design, accessibility and portability, leakproof seals and other features. Includes specifications. Chain Belt Co. of Milwaukee.

INSTRUMENTS AND CONTROLS

115 Technical Literature — Here are three recently published bulletins of interest to power engineers. Instrumentation Data Sheet 10.0–6 describes a duplex recorder which simultaneously plots two totally independent variables on one chart. Instrumentation Data Sheet 9.1–7 describes a strip chart recorder which, when coupled with a Kelvin bridge measuring circuit, comprises a most modern method of measuring rotor temperatures. Specification Sheet 415–1 covers air-operated diaphragm motor valves for use with either narrow throttling band or on-off instruments. All three bulletins available, list those wanted. Industrial Div., Minneapolis-Honeywell Regulator Co.

116 Pump By-Pass Control — Catalog 925, 4 pp, describes and pictures a by-pass control for protection of high pressure centrifugal pumps against overheating at low flows. Explains how control is designed for accurate measurement of feed water flow, precise adjustment of by-pass setting, simplicity of automatic control. Penn Industrial Instrument Corp.

117 Multi-Pump Tank Controls — Illustrated Bulletin 1110, 4 pp, describes company's pressure operated pump controls for elevated tanks with two or more pumps. Explains operating principle of twin-bellows design utilized in control for each pump, discusses other features. Gives typical specifications, installation tips. Automatic Control Co.

118 Metered Liquid Handling — Bulletin OG 400 contains 12 pp of selection and ordering data on positive displacement type meters for industrial, chemical and refinery applications. Explains and illustrates operation of meters, giving specifications, dimensions. Also presents several types of registers, register extensions, strainers and remote registration unit. Includes table of material recommendations for meter parts for use with nearly 200 different liquids. Rockwell Mfg. Co.

119 Combustion Guide — Publication 51–553 describes combustion meter (CO_2 recorder) telling its application as an index to fuel burning efficiency, explaining its operating principle and discussing its features. How meter works, and is installed, and how sampling is achieved are described and illustrated. Specifications included for both recording models and recording-indicating models. The Hays Corp.

120 Where CO Is a Problem — A simple, easily used carbon monoxide indicator is described in 2-pp Bulletin C1-101A, illustrated in color. Explains how this pocket-size instrument utilizes indicating gel and color chart to show presence and concentration of carbon monoxide in furnace rooms, mills, chemical plants, refineries, etc. United States Safety Service Co.

PACKINGS

121 Plastic Packings — This 4-pp illustrated bulletin describes company's "versi-pak" non-jacketed plastic packings, described as relatively inert with high compressibility and said to perform satisfactorily against a large number of fluids. Also included are description and service recommendations for company's Universal plastic packing. Packing Div., Raybestos-Manhattan, Inc.

122 Packings and Gaskets — Catalog P-100C, 32 pp, illustrates and describes the 95 most popular packings and gaskets in company's line, furnishing complete details of construction, service recommendations and size information on each item. A feature of this excellent booklet are charts showing specific recommendations for a wide variety of applications. Packing Div., Raybestos-Manhattan, Inc.

PIPING, VALVES, ACCESSORIES

123 Underground Steam Conduit — Eight-pp, well-illustrated Bulletin 511 describes a complete underground pipe conduit system for permanent protection, support and insulation of underground pipe lines. Includes specifications and a typical plot plan. W. H. Porter & Co., Inc.-Reid Hayden, Inc.

124 For Uniform Boiler Water — A continuous boiler blowdown assembly for maintaining correct boiler water concentration is described in this 4-pp illustrated bulletin. Gives features, specifications; explains and pictures operation of the assembly. Also describes briefly company's steam traps, air filters and pressure reducing valves. Kaye & MacDonald, Inc.

125 Coupling for Pipe Lines — Illustrated Bulletin 513, 4 pp, describing manufacturer's heavy duty Wedge-Lock coupling for temporary or permanent lines, stresses their speed and simplicity of connection. Complete specifications on this one-piece coupling are included in range of light weight pipe sizes from 8 to 30 in. dia. Naylor Pipe Co.

126 Stainless Welding Fittings — Sixteen-pp Catalog 1051 describes manufacturer's Schedule 5 and 10 IPS size stainless steel welding fittings, available for wide industrial application, for use with light gage pipe. Gives physical characteristics of the fittings, full dimensional information on elbows, laterals, tees, crosses, reducers, adapters and flanges. Gives tips on assembling of fittings, tells how to order them. Tri-Clover Machine Co.

127 Tape to Stop Corrosion — How to stop service pipe corrosion with tape is explained in this 4-pp illustrated

(*Continued on page 124*)

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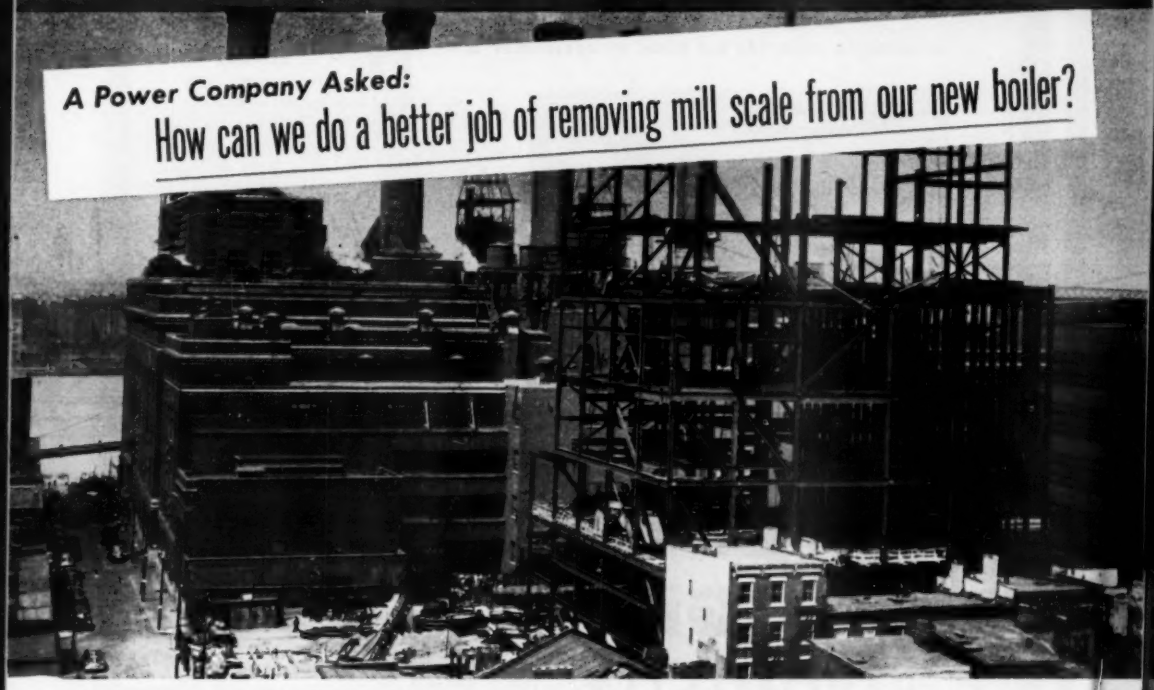
DOWELL SERVICE

CHEMISTRY APPLIED TO MAINTENANCE CLEANING PROBLEMS



A Power Company Asked:

How can we do a better job of removing mill scale from our new boiler?

Dowell Service removed mill scale AFTER ERECTION... leaving the internal surfaces clean for best operation!

A large power company installed a new 1,370,000 lb. per hour boiler. Specifications called for Dowell Service to remove the mill scale from the boiler *after erection*. This company found the Dowell way of removing mill scale to be good insurance for satisfactory boiler operation.

Dowell engineers filled the new boiler with specially selected liquid solvents designed to dissolve out mill scale. Unless it is removed, mill scale may retard heat transfer, slough off particles which abrade the system during operation, and act as a base for further corrosion. Dowell furnished trained personnel and special equipment to do the entire job in a few hours. Removal of mill scale *after* equipment erection can eliminate much of the extra care required in the handling of previously sand blasted or pickled tubes. It may also substitute for the grease-removing alkaline pre-boil.

Maintenance engineers in industrial plants throughout the country have found Dowell Service can provide *fast, effective and economical* cleaning of boilers, condensers, heat exchangers, water lines and other operating equipment. Experienced engineers will consult with you on your particular problems. Call Dowell today.

Other recent Dowell jobs:

Three Dowtherm boilers in a southwestern chemical plant were cleaned by Dowell Service. Carbonaceous type deposits were removed.

•

Two bubble cap columns in an oil refinery were clogged with a complex deposit of antimony and aluminum salts. After Dowell Service, the towers were found to be spotless.

•

Rotor and stator of a 625 K.W. turbo-generator were fouled with a carbonate deposit carried over from the boiler. Dowell Service cleaned blading completely in 3 hours. Result: Machine is running smoothly again.

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Baltimore	Detroit 2	Houston 2	Salem, Illinois
Wilmington 99	Chicago 4	New Orleans 12	Borger, Texas
Richmond 19	St. Louis 8	Ft. Worth 2	Midland, Texas
Jacksonville 2	Indianapolis	Shreveport 69	Wichita Falls, Texas
Atlanta	Louisville	Anniston, Alabama	Lafayette, La.

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★ ***Maintenance cleaning service for industrial heat exchange equipment.***

★ ***Chemical services for oil, gas and water wells.***

★ ***Magnesium anodes for corrosion control.***

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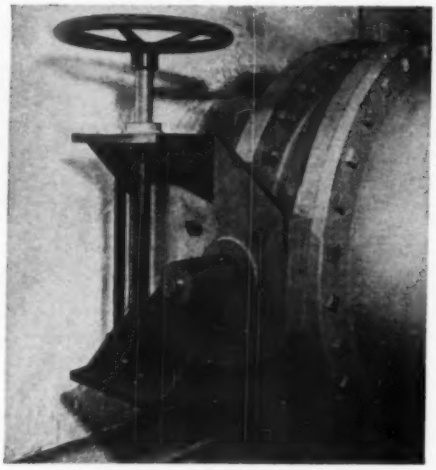
THE DOW CHEMICAL COMPANY

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



RUGGED Simplicity

Correctly engineered mechanically and metallurgically, all body assemblies of R-S Valves equal or exceed A. S. A. standards in every detail. These valves are designed and constructed for rugged service and provided with such safety factors that they will exceed service expectations as well as reduce pumping and blower costs.

Consider also the few working parts, greater control rangeability, the self-cleaning feature and the fact that R-S Valves are readily adapted to automatic operation. Know the rugged simplicity of R-S Valves, and get the most from your valve investment.

District offices are listed in telephone directories as, "R-S Products Corp'n Valves".

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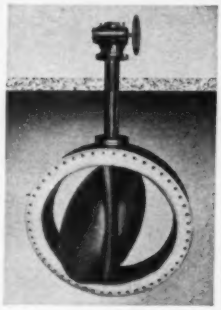
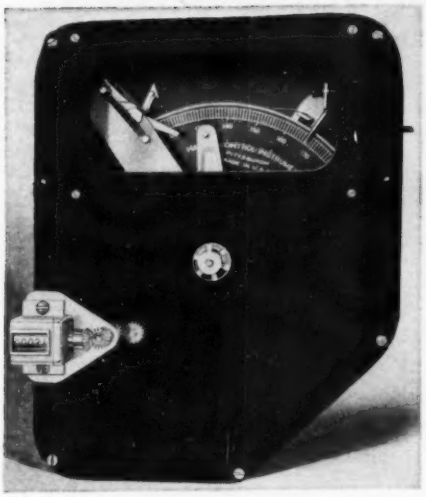


No. 739-740—Sixty-inch, 50-pound Heavy Duty Valve with gear reduction drive and handwheel for handling water at 40 psig. Vertical valve stem enclosed in steel pipe support. Thrust bearing absorbs vertical load.

No. 730—R-S Heavy Duty Floor Stand for rugged service in connection with any standard R-S handwheel operated valve.

No. 767—A 3-Way Valve (Two 24-inch 125-pound Cast Iron Valves bolted to 125-pound American Standard Tee). Electric motor operated by cross linkage. Automatic declutching handwheel for emergency operation.

Accurate integration over the entire range in HAGAN



RING BALANCE METERS

This wide range accuracy is due to the unique design and precision construction of the Hagan integrator.

In this integrator, a large toothed wheel is set in motion periodically. The movement at each interval is governed by the flow index pen and is proportional to the momentary rate of flow. The wheel is geared to a counter which registers the total flow through any period, by difference in the counter readings.

The Hagan integrator differs fundamentally from others in that all associated parts rotate around a common center. As a result, angularity errors are eliminated and only one simple adjustment is required for calibration throughout the range. The large six inch integrating wheel produces the required selectivity to integrate as low as two percent (of chart) with high accuracy. With this construction, wear between toothed wheel and the pawls is eliminated. There are no clutches to wear and slip.

The instantaneous pawl action also produces high accuracy under rapidly fluctuating flow conditions.

The graduations on the large wheel and pointer facilitate checking the calibration of the integrator at any point in the range in one minute or less.

The Hagan Integrator is a self-contained unit and may be mounted conveniently in any of the various types of Ring Balance flow meters, or pneumatic receivers.

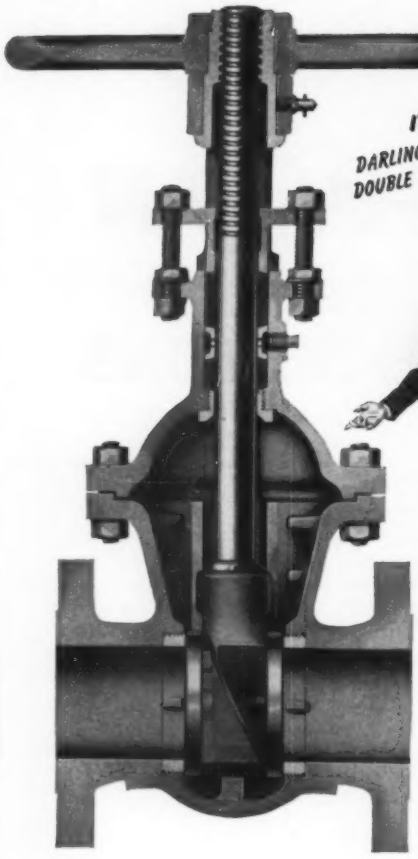
For full information on this and other features of Hagan Ring Balance meters, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Penna.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

WHY seat misalignment doesn't cause this Darling Valve to leak!



IT'S UNIQUE
DARLING SELF-ADJUSTING, DOUBLE DISC CAST STEEL GATE VALVE

NO gate valve body ever made is entirely immune to distortion caused by line stresses and temperature changes. Yet even slight distortion can throw the seats out of alignment—probably the most common cause of leaky valves and costly replacement.

That's one reason why Darling gate valves, with their unique wedging principle combined with fully revolving double discs and parallel seats, have the jump on other valves. They easily, *automatically* adjust for valve body distortion, cinching tight, leak-proof closure without destructive strong-arm tactics. Most important, you avoid costly down-time and repeated maintenance headaches.

But that's not all! Actually, this Darling principle offers several other equally important time-and-money-saving advantages. In plant after plant they add up to trouble-free performance and longer service life with a very minimum of attention.

GET ALL THE FACTS

Send for descriptive cast steel valve Bulletin No. 5003.

DARLING VALVE & MANUFACTURING CO.
Williamsport 19, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd. Galt 19, Ontario

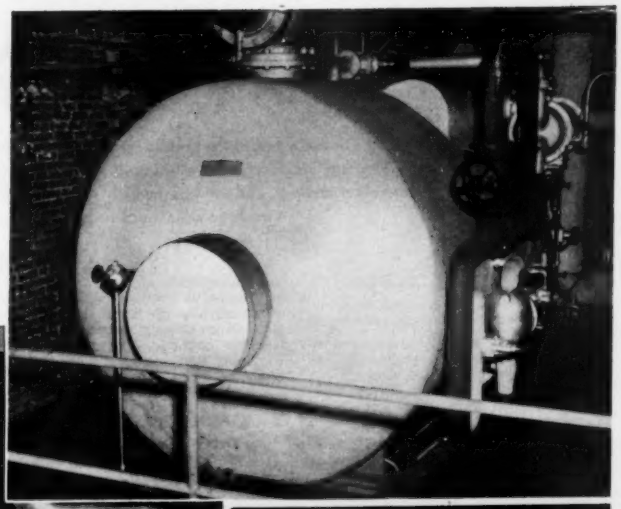
NOTE: *Darling gate valves are made in a wide range of sizes, types and constructions, including solid and slotted taper-seat wedge types, for all kinds of normal and corrosive services in pressures up to 1500 pounds.*

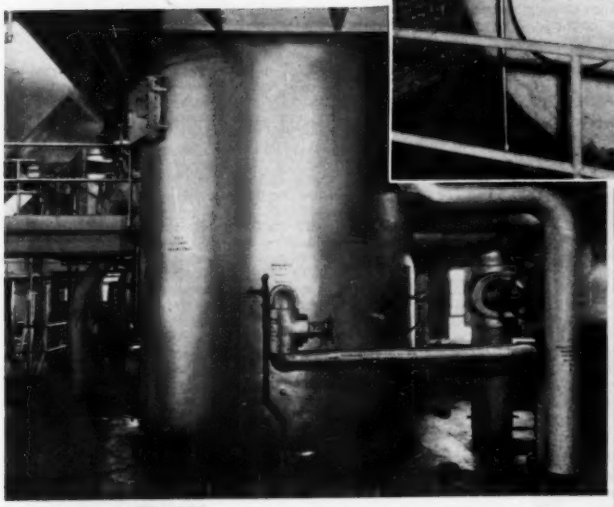
FOR PLUS VALUES, JOB-PROVED AGAIN AND AGAIN

Central Station

DEAERATING EQUIPMENT

by CONSECO



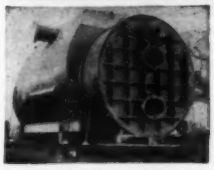


HORIZONTAL

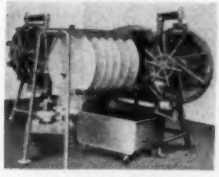
VERTICAL

BOILERS

EVAPORATORS



CONDENSERS



REFINER FILTERS

The two units shown here are installed in the central station of a large New England public utility. Each unit represents the very latest in engineering development and was designed and built by CONSECO. They are typical examples of CONSECO'S long, specialized experience on heat transfer equipment of all kinds.

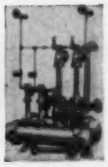
VERTICAL

This vertical, tray type Deaerating Feed Water Heater delivers 588,000 lbs. water per hour at a maximum of .005 cc per liter oxygen concentration. It is fitted with vent condenser and integral storage system. It operates with extraction steam.

HORIZONTAL

The horizontal unit illustrated is a tray type Conseco Deaerating Feed Water Heater delivering 150,000 lbs. of water per hour at maximum .005 cc per liter oxygen concentration. It was designed with an internal tray section having special construction arrangements to meet requirements of limited headroom.

CLOSED HEATERS



STEAM JET AIR EJECTORS

Send for illustrated literature. Ask Conseco Engineers for recommendations on condenser and heat exchanger equipment to meet your requirements and guaranteed to meet or exceed performance specifications.

CONSECO

Condenser Service & Engineering Co.

HOBOKEN, N. J.

NEW EQUIPMENT NEWS

WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the non-obligation, postage-paid card pages 45–46.

1—STRAIGHT TUBE CLEANER

For refinery and process heat exchangers; is fast acting, economical

The Model TP-301, an air-driven rotary shaft drill type tool, scavenges the tube with air or water while cleaning. It immediately removes deposits from completely plugged heat exchanger tubes, according to manufacturer, and because of its powerful action it does the job in fewer man-hours.

Incorporating many improvements, this new cleaner weighs only 15 lb and is only 13 in. long. It provides increased capacity, too, from $\frac{5}{8}$ up to $2\frac{1}{2}$ or even 3 in. OD tubes, company states, and operates on air pressure as low as 50 lb. Hollow shafting is available in one piece up to 20 ft, or in sectional threaded lengths. Thomas C. Wilson, Inc.

2—MANUAL CONTROL VALVE

Has totally enclosed gear reduction drive, extended shaft, floor stand

In heavy-duty Valve No. 788 the sealing of water pressure is obtained by utilizing a babbitted seat in the body and Monel or stainless steel welded to the periphery of the valve disc. This metal-to-metal seat gives satisfactory commercial shut-off in most installations, company says, adding that with a 350 ft head of ambient water, a 36-in. valve with a babbitted seat has a leakage of only 50 gph. Remote, automatic or semi-automatic controls are also available. R-S Products Corp.

3—DISTRIBUTION TRANSFORMER

With overload indicator operated by thermostatic element in top oil

Company explains that this new indicating device acts purely as a signal warning and doesn't interrupt continuity of service. It is designed to trip 80 C top oil temperature. This is said to correspond to 50 C maximum top oil rise above a 30 C average ambient temperature. When the oil reaches the predetermined temperature, a signal light snaps on and stays on until turned off by moving the handle indicator until pointer is on the reset mark. The handle is then returned to its original close position.

The indicator is described as an economical, maintenance-free device and suggested for systems where more complicated equipment isn't justified. Allis-Chalmers Mfg. Co.

4—AUTOMATIC DEGASSER

Has mild steel case, finished in black, treated to minimize corrosion

The re-designed Degasser is described as easy to disassemble. The interior mechanism is more accessible and the structural members of the case strengthened. Intended primarily for use in determination of steam purity, this unit is designed to produce continuously and automatically an approximately 50-50 split of a flowing steam sample; one fraction contains any dissolved solids that may be present, and the other any dissolved gases. Hagan Corp.

5—REFERENCE TEXT

Is low-cost, pocket size collection of useful tables and formulas

The Card-All is a wire-bound book, only $4\frac{1}{2}$ by $6\frac{1}{2}$ in. in size, and composed of varnished cardboard pages. It's indexed in color and saves a lot of searching through handbooks to locate needed tabular material. No explanatory written matter is included — just tables and engineering data. Contains conversion tables; decimal equivalents; tap and clearance drill sizes; table of natural function of angles; formulas for trigonometric solution of triangles; properties of metals; dimensions of screws, washers, taper pins, and many common formulas used in engineering. A single Card-All costs $1.00; quantity discounts are available. General Design Co.

6—BRONZE WELDING ROD

Is adaptable for use on old, "dirty" cast and malleable iron

EutecRod 148FC features an extra-thin initial "tinning" action and is said to be capable of eliminating pre-welding preparations required by many rods. It is also said to flow where directed without extensive chamfering, even on butt joints where necessary.

Each rod is covered with a new type of flux coating yielding full strength joints on old, corroded and dirty cast iron, manufacturer says. Tensile strength is listed up to 55,000 psi and Brinnell hardness 75–120. It is claimed to be the first bronze welding rod which can be used in chamfer joints as well as square butt and lap joints. Eutetic Welding Alloys Corp.

7—COUNTERBALANCED COVER

For underground vaults or manholes, designed for easy opening

To open this cover you simply insert a combination key-handle and give it a half turn. Lifting the cover to its vertical open position is a one-handed job, says manufacturer, because of the counterweights, which also hold the cover in a protective position and ease the load.

It's pointed out that this cover won't slam or drop into vault and that it can be opened from the inside of the vault by one man. Since the key-handle is needed to open the lock, this cover isn't subject to tampering by unauthorized persons. The E. H. Wachs Co.

8—VOLTAGE REGULATORS

Single-phase, dry-types induction units in ratings of 9.6 to 24 kva

Newest of manufacturer's dry-type voltage regulators, these single-phase Inductrols are intended to widen the field of application in which uniform voltage control can be obtained economically with small regulators. They are available for single-phase circuits, 600 v and below up to 1000 amp.

With standard controls they can be used for secondary circuit regulation where lighting and power are supplied from the same lines in mills, factories, large buildings. They can also be used in laboratories for controlling voltage in testing meters, and in instrument transformers, as well as for operating resistance and induction furnaces.

Basically the Inductrol consists of a shunt winding on the rotor and series winding on the stator. Varying position of rotor with respect to stator causes a variation of voltage in the series winding that will raise or lower the output voltage gradually, as required by load changes. Inductrol equipment is housed in an all-steel cabinet with "live" parts enclosed. Transformer and Allied Product Divs., General Electric Corp.

9—THREAD COMPOUND

Is designed to prevent seizure of pipe, bolt and stud threads

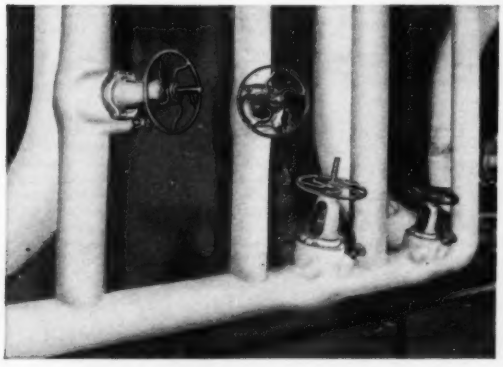
Led-Plate, a new metallic compound is announced as combining the advantages of a lubricant and sealer to solve the problem of thread seizure. This anti-seize compound is reported to have effective results when used in temperatures from −350 F to above 2900 F. The metallic elements, of which over 70 per cent is powdered lead, are held in suspension in hydrocarbons, company explains, and the materials will not dry out. Compound can be used for steam, gas, water, air, oil, ammonia and various chemical connections. A sample tube is available on request. Armite Laboratories.

a better gate valve for 600-pound services ...CRANE pressure-seal bonnet design

Better—because these Crane valves completely eliminate bonnet joint maintenance. And because they assure power plants—industrial and utility—ideal flow conditions, with many added cost-reducing advantages.

For instance, they save on erection and suspension costs, because, size for size, Crane Pressure-Seal Bonnet Gates are much lighter in weight and more compact than flanged bonnet steel valves. Insulating Pressure-Seal valves takes less time and materials because of streamline contouring.

For complete information about Crane 600-Pound Pressure-Seal Bonnet Gates—also companion lines of 900 and 1500-Pound Gates, Globes, Angles, and Stop-Checks—send for Circular Ad-1819, or ask your Crane Representative for a copy.



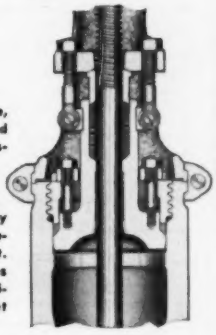
Boiler feedwater header in central station. No danger of bonnet-joint leakage; valves are Crane Pressure-Seal Bonnet Gates.

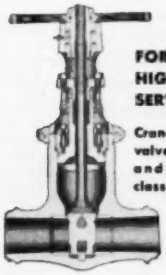
Patented and Patents Pending

600-Pound Butt Welding Gate for temperatures up to 1000° F. max.

NO BONNET-JOINT LEAKAGE OR MAINTENANCE

Bonnet joint is inside the valve, sealed with a wedge-shaped seal ring. Internal fluid pressure, acting upon the entire underside of bonnet, forces bonnet against seal ring and wedges it between the body and bonnet to form a pressure-tight metal-to-metal joint. Since pressure tightness does not depend on bolting, no periodic restressing of bonnet joint is needed.





FOR HIGH-PRESSURE HIGH-TEMPERATURE SERVICES

Crane Pressure-Seal Bonnet Gate valves are also available in 900 and 1500-Pound pressure classes.

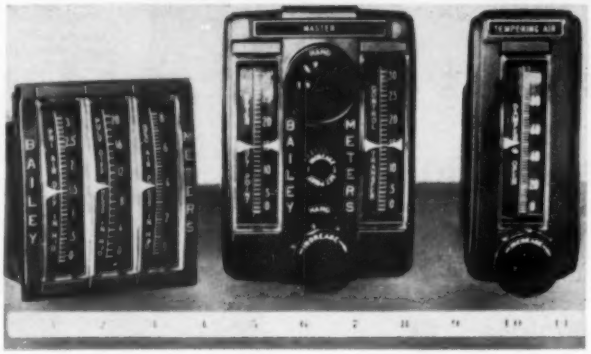
CRANE CO.

General Offices:
836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

10—MINIATURE CONTROL INSTRUMENTS

For saving space, operating expense in centralized control rooms



Pictured above, left to right, are the multi-point indicator, selector valve and remote manual relay which compose this manufacturer's new Mini-Line of control equipment. Their use makes it practical to concentrate into a small space before a single operator all information and controls for operating one or more boilers, turbines or process units. Since these instruments require much less space than their standard counterparts, they are adaptable for use in the new bench type instrument panels.

Announced as the greatest space saver in the Mini-Line is the multi-point indicator, made up of individual vertical-scale units nested together in whatever quantities are needed for comparing a set of related factors. The three-unit model shown is only 4½ in. wide and 4¾ in. high — an 87 per cent space saving in panel area. Individual scale units may be arranged in any position in the indicator to cause their pointers to follow a horizontal or diagonal pattern when conditions are normal. If a factor shows up "out of line" it is quickly spotted.

Using 52 per cent less space than a standard selector valve, the 4½ by 6½ in. Mini-Line unit is designed to provide smooth, instantaneous transfer between remote manual and automatic operation of air-operated controls. Transfer is made by turning the upper knob. The center knob may be used for remote set point adjustment or for providing a bias to control pressure. The lower knob is for remote manual control.

For factors not warranting automatic control and needing only occasional manual adjustment, the remote manual relay is used. Only 2⅝ by 6½ in., it is reported to save 72 per cent of the space required for standard size remote manual relays. Bailey Meter Co.

11—ISOLATION BOX

For multiple set operation, is bakelite housed, non-powered

The size of a standard outlet box, this new isolation box is for use with company's Tacoplex Antenna Distribution System. It contains a matching network of resistors providing an isolation factor between receivers of at least 30 db, with a minimum signal drop across the outlet. No power is required. Terminals are provided for 300-ohm twin-lead to the receiver. Mounting holes allow for baseboard or wall concealed mounting. Technical Appliance Corp.

12—MOLDED PACKINGS

Are available for use on hydraulic and pneumatic equipment

These packings are compression molded from special fabric and a neoprene compound credited with unusual wear qualities and resistance to a wide variety of hydraulic fluids. They're held to precision limits during the compression process, company says, and for this reason are recommended for hydraulic and pneumatic cylinders, pumps and valves, as static seals or in traverse action applications. Available designs include cup, flange, U-ring O-ring. Periflex, Inc.

13—TACHOMETER

For monitoring speeds of many machines from one convenient location

This new tachometer, which employs a simple machine selector knob, is designed to permit quick, accurate speed tests and comparisons even when the indicator is 1000 ft away from any of the machines. Over 50 standard full scale range markings are available. Direct-readings in any units, such as rpm, fpm etc. from any speeds between 1/10 to 100,000 rpm are offered by use of company's various tachometer heads. Connections between heads on the machines and the indicator are made by ordinary electric wiring. Metron Instrument Co.

14—BLACKLIGHT LAMP

Utilizes long wavelength ultraviolet for detecting liquid leaks

Requiring less power than some of the lamps previously used for blacklight leak detection, the new Raymaster Model TFS4-B90 Blacklight Exploring Lamp is announced as adaptable to operation under all conditions. It may be battery operated, company states, and hazards of shock from power circuits are eliminated.

The detector is used in a darkened area. In operation, an extremely dilute solution of fluorescing agent is placed inside the container to be tested. Any flow through the wall is signalled by a bright glow under the influence of the rays from the exploring lamp. Equipment is portable; complete battery unit weighs 11 lb and lamp unit weighs 1 lb. Water soluble and oil soluble fluorescing solutions available. George W. Gates & Co., Inc.

15—TRUCK MOUNTED TOWER

Is extensible, hydraulically-operated unit for one-man handling

The Sky Hook Model 51, although designed for field servicing of aircraft, is adaptable for maintenance work on buildings and power lines. It can be mounted on any standard truck chassis with 170-in. wheelbase and similar to the International L-152. It requires only one operator — no ground man. Controls for moving up, down and laterally are at operator's hand on the boom-point platform rail. Hydraulically actuated outriggers are used to provide a safe ground base.

This truck has a top working range of 51½ ft and moves in a 280 deg arc around the turntable base. The jointed boom folds over the truck cab to a traveling height of 11 ft, and the width is 6 ft 8 in. Mobile Towers, Inc.

16—STEAM HEATING COILS

For use with air conditioning coils, or as tempering and booster units

These coils are available in both single and double row design. The single row are suggested for booster and tempering service in long heating ducts, and the double row for heavy duty or mixed air heating service. Capacities range from 60,000 to 775,000 Btu per hour.

The units are constructed with heavy gage steel casings, copper tubes and headers, seven aluminum fins per inch and all fins collared to tubes. Coils are tested 350 lb air pressure for steam working pressures to 125 lb. Rempe Co.

17—END SEAL

For waterproofing terminals of multi-conductor sheathed cables

According to manufacturer of the Okoprene End Seal, many methods now used for terminating cables don't provide adequate protection for the individual conductors and are not waterproof — when moisture lodges around the conductors under the sheath the cable deteriorates. This new end seal is made from the same neoprene formula as company's cables and is described as mechanically strong and resistant to sunlight, air, ozone oils and chemicals.

The seal is designed to slip over cable easily and fit snugly; it is applicable to cable diameters from ¾ to 2 in. It's cone shaped to receive the filling compound which hardens to form a permanent moisture-proof seal and keep the conductors properly spaced. The Okonite Co.

It started with a V-crimp in Gaskets

In the new high-pressure, high-temperature power and processing plants, it is the spring-action of Flexitallic Spiral-Wound Gaskets that makes flanged joints effective. Prevents seepage caused by line strains, thermal shocks or vibration. Simplifies breaking and reassembly of joints. With pressures from vacuum to 2500 lbs. and with temperatures from -200° F. to 1800° F., the V-crimp construction of the Flexitallic Gasket results in a highly resilient seal and a low seating stress on the bolting. Properties of metal, type of filler, relationship of metal to filler—all these are variables in the design of a Flexitallic Gasket. Made for all standard joint assemblies in four thicknesses .125", .175", .250" and .285". Also available for special joint assemblies up to 104" diameter . . . Flexitallic Gasket Company, Eighth and Bailey Streets, Camden 2, New Jersey.

Flexitallic®

SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS, PROCESS EQUIPMENT

*Look for the name FLEXITALLIC stamped into the metal spiral of every genuine Flexitallic Gasket—look for *Flexitallic Blue* in gaskets with asbestos filler.

REPRESENTATIVES in principal cities (*Indicates local stocks available): ***AMARILLO**—Moorlane Co.; **ATLANTA**—Boiler Equipment Service Co.; ***BALTIMORE**—Tate Engineering & Supply Co., Inc.; **BOSTON**—G. H. Thomson; **BUFFALO**—Lane Engineering Co.; ***CHICAGO**—A. L. Crump & Co.; **CINCINNATI**—J. A. Gerlach; **CLEVELAND**—Ilse Power Control Co.; ***DENVER**—Moorlane Co.; **DES MOINES**—Carl Grimes & Co.; **DETROIT**—Metrol Co.; ***HOUSTON**—The Crellin Corp.; Gulf Engineering Co., Inc.; Power Specialty Co.; **KALAMAZOO**—Metrol Co.; ***KANSAS CITY**—Moorlane Co.; ***LOS ANGELES**—Power Engineering & Equipment Co., Inc.; **MILWAUKEE**—A. N. Dietze; **MINNEAPOLIS**—Plant Equipment, Inc.; ***MOBILE**—Marine Specialty Co.; ***NEW ORLEANS**—Eagle Asbestos & Packing Co.; ***NEW YORK**—Consolidated Packing & Supply Co.; ***NORFOLK**—Empire Machinery & Supply Corp.; ***OKLAHOMA CITY**—Moorlane Co.; ***PHILADELPHIA**—Energy Control Corp.; **PITTSBURGH**—T. J. Barry; ***PORTLAND**—W. J. Robbins; **ST. LOUIS**—Lane Machinery Co., Inc.; ***SAN FRANCISCO**—Cordes Brothers; Transmission Engineering Co.; ***SAVANNAH**—Southern Marine Supply Co., Inc.; ***SEATTLE**—International Sales Corp.; **TOLEDO**—Metrol Co.; ***TULSA**—Moorlane Co.; **WICHITA**—Moorlane Co.; **WILMINGTON, DEL.**—Energy Control Corp.; **IN OTHER COUNTRIES**—***MONTREAL**—Tube Engineering and Service Co., Ltd.; ***VANCOUVER**—Fleck Bros., Ltd.; ***HONOLULU**—American Factors, Ltd.; ***MEXICO CITY**—Consultores y Abastecedores, S.A.; ***SAN JUAN**—F. R. Lluch Co.; **ROTTERDAM**—Van der Mark & Co.

BALDWIN-HILL COMPANY
902 BREUNIG AVE. TRENTON 2, NEW JERSEY

18—SERVICE KITS

For repair, conversion work on pressure regulators, lubricators

Besides providing the next best thing to new equipment these service kits are intended to reduce time and expense of repair work for users of this manufacturer's equipment, and to facilitate conversion to meet changing production requirements. In all, 20 kits are available. Fourteen repair kits are offered for use with four types of regulators and with all types of company's oil fog lubricators. Six kits are for converting conventional air pressure regulators to air-relieving and liquid pressure types.

The kits contain from four to 11 new parts and include illustrated instructions. When repair work is necessitated by a part failure manufacturer recommends that all new parts in the kit be installed at the time to prevent possible failure of other worn parts. C. A. Norgren Co.

19—FLOORING MATERIAL

Of synthetic rubber, offers high strength and long service life

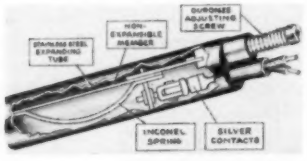
Vulcrete Flooring is said to be highly resistant to acids, alkalis, water and other destructive agents, and to be economical and easily applied. It dries to a light concrete color and bonds with wood, metal, concrete, brick, slate, stone, asphalt mastic, and other bases, according to company, and it has high resistance to heavy point loads.

Vulcrete is suggested for leveling and resurfacing worn or splintered floors wherever high sanitation is desired, as well as for laboratory and work tables. It's described as sound dampening over steel plates. Flash-Stone Co., Inc.

20—THERMOSTATS

Expanding-tube type, in conduction, convection or immersion models

This new Saico Thermostat utilizes a stainless steel tube as the expanding member and an Invar strip as the non-expanding member. An Inconel spring is used to provide fast make and break action. There is a Duronze adjusting screw for setting of control point at any temperature to 600 F, and massive silver contacts are designed to provide two breaks in series.



Series 12 of these new thermostats is ½ in. dia, 2 3/32 in. long for 600 w loads at 110 v, or 230 v a-c or d-c, and sensitivity is given 0.2 F on 1 amp load. Series 58 is 5/8 in. dia, 3 in. long for 1000 w loads at 110 or 230 v a-c or d-c, sensitivity 1 F. Smith Control & Instrument Corp.

21—TEMPERATURE INDICATOR

In lacquer form, is available for indicating temperature to 2000 F

Previously available for use only for temperatures up to 1950 F, Tempilaq can now be obtained in 12- or 13-deg steps from 113 to 400 F and in 50-deg steps from 400 to 2000 F. Tempil Corp.

22—TORQUE-INDICATING TOOL

Is new device for driving studs to precise torque tolerances

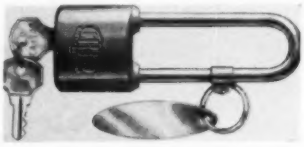
The new Garvin Torque-Indicating Driver is designed to automatically measure the torque as it drives studs, nuts, screws or fasteners. Manufacturer says it eliminates stud breakage, reduces scrap loss and eliminated need for hand-torquing inspections. This driver is built around a standard deflection-type torque wrench. In operation, minimum torque is indicated by the wrench and by a green light; maximum torque by the same wrench and by a red light. Lights and torque scale are on the front of the unit for easy reading.

The unit can be furnished with a relay for interrupting power source and automatically stopping rotation when desired maximum torque is reached. Adjustments for low and high limits are made by two screws using torque wrench as gage. The wrench can be removed to check calibration. The driver is made in six capacities from 0-100 to 0-2000 in.-lb. Electric, high-cycle or air motors can be specified. The smallest model is portable. Tru-Circle Products Co.

23—SAFETY PADLOCKS

For protection of boiler cleaners and electrical repairmen

The Model P65R Personal Safety Padlock is designed to protect those whose safety requires that they lock out valves or switches while performing out-of-sight jobs. Features of the lock include 2¾ in. metal shackles and attached metal tags for employee's name or number. Standard locks have disc tumbler mechanism with 200 possible key changes. If desired they can be keyed alike or master keyed. Corbin Cabinet Lock Div., The American Hardware Corp.



24—VERTICAL MOTORS

Solid-shaft, capacitor type, with standardized mounting dimensions

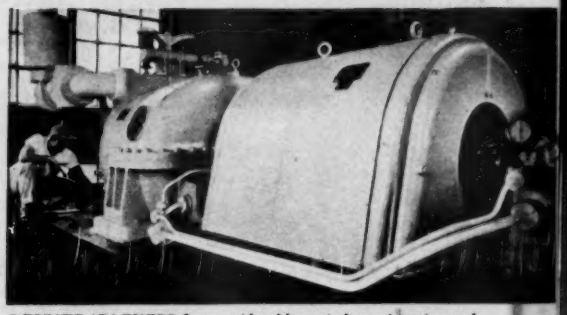
An addition to company's Tri-Clad line of integral-horsepower, single-phase, capacitor motors, these new ones are available in ratings from ¾ to 5 hp, and said to feature quiet operation. Their principal application is on jet pumps and other assemblies, such as those for supplying water for irrigation. Normally furnished as part of the complete pumps, they are suitable for outdoor use where climate is not severe.

The Tri-Clad construction is intended to provide the motor with protection from physical damage, electrical breakdown and operating wear and tear. Dimensions are the same as those of company's polyphase motors of the same size, permitting interchangeability without modification of mounting. An optional accessory for use with these motors in ratings of 2 hp and less is an automatic thermal protective device which disconnects the motor from the line when the limiting temperature is reached. Small and Medium Motor Divs., General Electric Co.

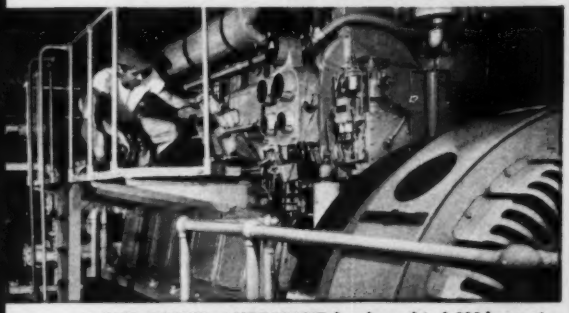
NANTUCKET ISLAND can't tie in with mainland power facilities and must therefore be entirely self-sufficient. To assure unfailing performance, the Nantucket Gas & Electric Company uses Sun lubricants exclusively. Also, engineers of the utility, of the diesel builders, and of Sun Oil cooperated to make possible a unique, three-way use of one inexpensive Sun fuel.

HOW SUN PROTECTS NANTUCKET'S POWER

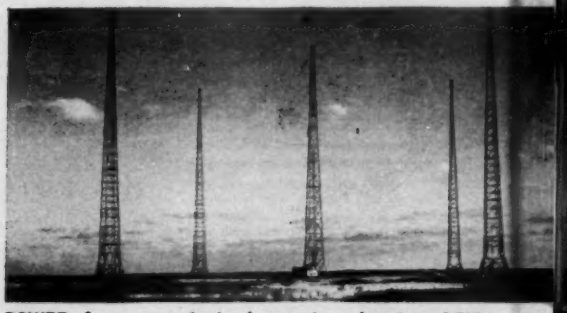
THE ISLAND'S POPULATION drops from around 16,000 to some 3,800 when the vacation season ends. With the power load fallen off so drastically, much of NG&E's equipment lies idle and subject to condensation during this extended time.



DESPITE IDLENESS for considerable periods, turbine journals, bearings and controls remain free at all times of sludge, rusting and corrosion—thanks to the protection of Sunvis 916. Its special metal-wetting additives displace any moisture that may be present.



A SUN DIESEL LUBRICANT has kept this 1,000-hp engine purring almost 15,000 hours. A single heavy, low-cost Sun fuel drives NG&E's diesel, fires its boilers, enriches its illuminating gas.



POWER for a new navigational transmitter, throwing a 1,700-mile beam for guiding aircraft, is supplied by Nantucket G&E—more evidence of the reliance placed on its Sun-lubricated plant.

For complete information about Sun's turbine and diesel oils, or for the services of a Sun representative, call the nearest Sun Office, or write to Dept. PP8

SUN INDUSTRIAL PRODUCTS

SUN OIL COMPANY, PHILADELPHIA 3, PA. • SUN OIL COMPANY, LTD., TORONTO AND MONTREAL

SUNOCO®

25—SALT TABLET DISPENSER

Is ornamental, easily used wall unit, holds 750 tablets

Suggested for location near a drinking fountain as a means of encouraging the use of salt tablets during hot weather, this glass-and-plastic holder keeps the tablets visible, easy to get at. A single dispenser costs $2.50; 1000 ten-grain salt tablets cost $.75. General Scientific Equipment Co.

26—TOP PRESSURE INDICATOR

For medium and high-speed internal combustion engines; two models

Described as a reasonably priced and reliable instrument, the Peak Pressure Indicator is available in two models. One of these, employing a bellows unit, is designed for quick, accurate measuring of compression or maximum firing pressures in the cylinder of an engine while operating. It is intended for use on engines of all speed ranges and standard model is calibrated for pressures to 1500 psi. Operation is automatic and readings may be taken quickly.

The other model, a fuel line pressure indicator, checks fuel pump pressures on diesel engines and is described as particularly useful on those utilizing high viscosity oil fuels. In operation it utilizes a piston operating in a cylinder. Suitable for pressures to 15,000 psi, it is graduated at 100 psi intervals. With multi-cylinder engines, the need for an indicator for each fuel line is obviated by a simple automatic cock connected to each line, company explains, only one or two indicators being needed for transferring from cock to cock. Dobbie McInnes Ltd.

27—INDUSTRIAL CLEANER

Is vibrating-pneumatic unit; operates from compressed air source

Manufacturer of this new cleaner explains that it has a vibrating air valve that creates by the jet principle an agitating suction, which forces dirt and metal particles into a container. By operating a second of two finger-tip control valves, a vibrating external air jet is created. This jet is directed through the cleaner head to dislodge dirt and metal particles from inaccessible places to spots where they can be picked up by changing to a suction action.

Air consumption is reduced because of the vibrating valve action that cuts off air supply 2000 times per min. The cleaner head is polished aluminum; wands are lightweight tubing. No oil is required, company says, because oil impregnated powdered metal parts are used.

Cleaner comes in both tank and "pick-a-back" models. In the latter the dirt container is supported on the back of the operator by a belt and harness assembly. It weighs 7½ lb complete. Castered tank models for both wet and dry cleaning come in 20 to 55 gal capacities. Cleaner operates from any compressed air source of 80 psi and up. Vibro-Pneumatic Cleaner Co., Div., Patterson Products.

28—FORCED DRAFT FAN

Is designed for efficient conversion of velocity to static pressure

Features announced for this new fan include large, deep inlet cones streamlined to reduce turbulence at the inlet; open space between wheels of double wheel models, instead of a common center disc, permitting complete fourway diffusion of the air leaving the wheels; and an oversize housing to assist diffusion. It is also noted that precisely shaped backward curved blades are designed to offer a nearly perfect aerodynamic flow across the leading and trailing surfaces to further contribute to a smooth flow of air through the fan. The Thermix Corp., Prat-Daniel Corp.

29—FIRE EXTINGUISHER

Is 4-lb capacity dry chemical type with rubber hose

The Model 4-B is designed for ease of operation, flexibility in fighting overhead and ground-level fires, and maximum extinguishing effectiveness for inexperienced operators. Discharge time has been increased on this model to give untrained personnel more time to extinguish the fire. Operating range is 12 to 15 ft. A self-closing nozzle is provided to make the unit weathertight. When fully charged the B-4 weighs 10½ lb. Ansul Chemical Co.

30—HOT LINE POLES

Have tough plastic coating over wooden core for increased safety

These poles are made by extruding Tenite plastic over the wooden core. They are available in 1¼ to 2½ in. dia and in lengths from 2 to 20 ft, and fitted with attachments and tools for changing insulators, fusing transformers, removing hot line clamps, operating switches and other high-voltage power line jobs. The plastic has good dielectric strength and is reported satisfactorily tested at 75,000 v and higher potential-per-foot for 5 min.

It is pointed out that the slightly higher initial cost of these poles is compensated by reduced maintenance. The tough Tenite is used to resist abrasion and wear and help keep the wooden core dry and thus safe for linemen to use. Tenite is also described as low in moisture absorption, highly resistant to outdoor exposure. Tennessee Eastman Co.

31—THREE-WAY VALVE

Is packless, pilot controlled and internal piston operated

This valve is designed for controlling automatically the alternate application and exhaustion of pressure to and from equipment, cylinders or diaphragm chambers such as in the operation of diaphragm motor valves, air or hydraulic cylinders. The operating characteristic is such that when the solenoid is energized, the exhaust port is closed and the pressure is applied to the delivery port. When the solenoid is de-energized, pressure supply is cut off and delivery port is connected to the exhaust.

These valves are suggested for handling air, gas, oil or any other non-corrosive fluid at temperatures to 180 F. Pipe sizes are 1, 1¼, 1½ and 2 in. with designs suitable for 125 and 250 lb operating pressures. Standard solenoids are for 115 or 230 v a-c or d-c and for 25, 30, 50 or 60 cycles. Automatic Switch Co.

32 — HYDRAULIC POWER UNITS

Combine reservoir, pump and motor into compact, practical unit

Included in this new line are 224 standard models in three basic series: low pressure units supplying up to 1750 psi and ranging from 1½ to 50 gpm in single pump models, or to 100 gpm in double pump models; Hi-Low units providing a dual pressure source by combining a high pressure and low pressure pump with automatic unloading of the low pressure pump; and Hi-Pressure units supplying up to 10,000 psi and ranging from 1½ to 5 gpm in single pump types and to 10 gpm with double pumps.

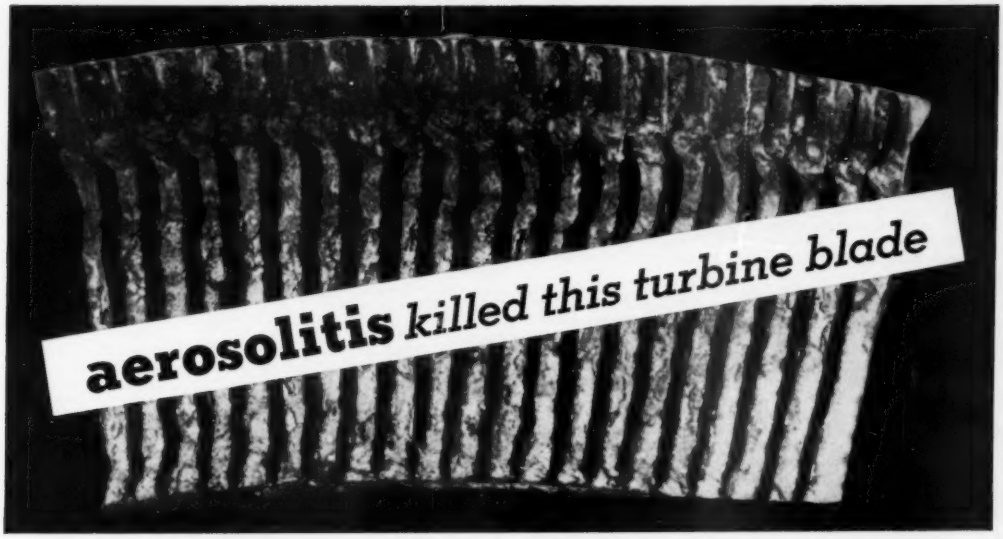
It is pointed out that the Hi-Low units provide rapid movement of a ram or cylinder, or quick closure of the daylight opening stroke of a press, then automatically unload the high volume pump, still pumping a low volume at a high pressure for the work portion of the cylinder or press stroke. This automatic unloading feature reduces the power requirement by one-half over a non-unloading system, according to manufacturer, and provides an efficient, economical solution to the rapid closure problem. Haskel Engineering and Supply Co.

33 — PNEUMATIC OPERATOR

For catalyst slide valves on throttling control services

Specially designed for accurate positioning of the large valves commonly used for handling spent and regenerated catalyst and for back pressure control of flue gases on catalytic cracking processes is this new model of the Cono Rotomotor, company's pneumatic gear driven operator.

Operating through a gear drive and threaded stem, the Rotomotor is basically a self-locking mechanism. A continuously connected handwheel and declutching lever also provide for optional manual operation. Repositioning is by means of a tape-type positioning device designed to permit long travel with high accuracy of valve stem positioning. Rotomotors operate entirely from plant air supply and are available for various travels, speeds, stem diameters and thrust loads. Conoflow Corp.



Dearborn polyamide anti-foams prevent this

deadly boiler disease

Here is an unretouched photo of a turbine blade that was *killed by aerosolitis.* Replacement was, of course, both necessary and expensive.

But *aerosolitis*—more prevalent with some waters than with others—can be easily and inexpensively prevented with Dearborn Improved Polyamide Anti-Foams. In addition to inhibiting the formation of harmful *aerosols,* Dearborn Polyamide Anti-Foams prevent foaming to produce purer steam—eliminate scale formations—condition sludge —are compatible with other treatment.

IF YOU USE STEAM for power or process, investigate the time-, money-, and labor-saving advantages of Dearborn Polyamide Anti-Foams and the complete Dearborn Industrial Water Treatment and Engineering Service. A Dearborn engineer is at your service. The coupon is for your convenience.

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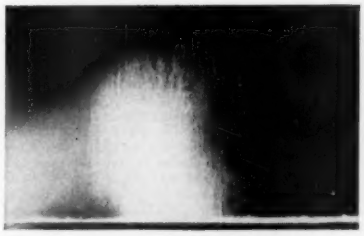

AEROSOLITIS AT WORK

Aerosols are tiny drops of water dispersed in the steam which cause encrustation on superheaters, foul turbine blades. When this happens, boilers have *aerosolitis,* and costly shutdowns and repairs will result.

Dearborn Chemical Company, Dept. PG
Merchandise Mart Plaza
Chicago 54, Ill.

Gentlemen: Please send:

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- ☐ Bulletin on Dearborn Industrial Water Treatment and Engineering Service
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POWER PLANT Construction News

Chapman, Ala. — W. T. Smith Lumber Co. has approved plans for extensions in boiler plant in connection with a modernization program at mill, to include installation of a new 5000-hp boiler unit and auxiliary equipment. Entire project will represent a reported investment of about $250,000. Rust Engineering Co., Exchange Bldg., Birmingham, Ala., is engineer and will supervise work.

Demopolis, Ala. — Borden Co., Chemical Div., 350 Madison Ave., New York, N. Y., adhesives, molding compounds, and allied specialties, plans boiler plant at proposed new branch factory on 20-acre tract of land, near Demopolis, recently acquired. It will consist of several one and multi-story buildings, equipped for production of formaldehyde and liquid urea resins. No official estimate of cost announced — will represent investment of several million dollars. Work scheduled to begin soon.

Pine Bluff, Ark. — Arkansas Power & Light Co., Pine Bluff, is projecting plans for two new steam-electric generating stations on sites to be determined in near future. Plants will have gross output of 270,000-kw, and are scheduled to be ready for service in 1955. Entire project reported to cost about $15,000,000, including transmission lines, power substations, and other operating facilities.

Enfield, Conn. — Connecticut Light & Power Co., 36 Pearl St., Hartford, through its wholly-owned subsidiary, Windsor Locks Canal Co., Windsor Locks, Conn., plans hydroelectric power plant on Connecticut River, near Enfield. Project will consist of power dam, four hydraulic-generating units, with total rated capacity of 42,000-kw, transmission lines and other operating facilities. No official estimate of cost announced. Application for permission has been made to Federal Power Commission.

Ellaville, Fla. — Florida Power Corp., St. Petersburg, Fla., plans new steam-electric generating plant on Suwanee River, near Ellaville, where site has been selected. Cost reported about $6,000,000, with turbine-generator, high-pressure boiler, and auxiliary equipment. Proposed to begin work in near future.

Pensacola, Fla. — Chemstrand Corp., care of American Viscose Corp., Marcus Hook, Philadelphia, Pa., recently organized as a joint interest of that company and Monsanto Chemical Co., 1700 South Second St., St. Louis, Mo., plans power plant at proposed new mill for nylon yarn production on 2000-acre tract of land, fronting on Escambia River, near Pensacola. Project will comprise a number of large units, and is reported to cost in excess of $5,000,000. Work is scheduled to begin in fall. Osborne Bezanson is president.

Rome, Ga. — Mead Corp., 118 West First St., Dayton, Ohio, writing, book, and other papers, plans power house at proposed new pulp and paper mill near Rome, where site has been purchased on Coosa River. Project will comprise a series of one and multi-story units, equipped for large capacity. Entire program is estimated to cost about $21,000,000. Proposed to begin work at early date.

Manilla, Iowa — Municipal Service Dept., plans extensions and improvements in municipal power plant, including installation of new 400-kw Diesel engine-generator and auxiliary equipment. Harry L. Daasch & Associates, Dunlap, Iowa, are consulting engineers. Estimates of cost are being made.

Pella, Iowa — Municipal Power & Light Dept., has plans for extensions and improvements in municipal steam-electric generating station, with installation of new 4000-kw turbine-generator and auxiliary equipment. No estimate of cost announced. Brown Engineering Co., Knights of Pythias Bldg., Des Moines, Iowa, is consulting engineer.

Flint, Mich. — State Building Dept., Lansing, Mich., has plans maturing for new power plant at Michigan School for Deaf, Flint, estimated to cost about $500,000, with boilers, generator, and auxiliaries. O'Dell, Hewlett & Luckenbach, Dime Bank Bldg., Detroit, Mich., are engineers.

Duluth, Minn. — Minnesota Power & Light Co., 30 West Superior St., is arranging fund of $10,380,000 to be used for expansion and improvements in 1952, including generating stations, transmission lines, power substations and other operating facilities; also, appropriation of $6,300,000 to be used for similar purposes in 1953. As recently reported in these columns, company plans new steam-electric power plant near Aurora, Minn., with capacity of 200,000-kw.

Hibbing, Minn. — Public Utilities Commission, plans expansion and improvements in municipal steam-electric generating station, with installation of two new steam-generating units and auxiliary equipment. Cost about $750,000. Pfeifer & Shultz, Wesley Temple Bldg., Minneapolis, Minn., are consulting engineers.

Kansas City, Mo. — Kansas City Power & Light Co., 1330 Baltimore Ave., is arranging financing in amount of $30,000,000 to cover part of cost of 1951–52 construction and improvement program, including increase in generating capacity, power substations, transmission lines and other operating facilities.

St. Louis, Mo. — Board of Public Service, City Hall, plans power plant in conjunction with new municipal incinerator station, near foot of Gasconade St. Installation will include a boiler unit, 3,000-kw turbine-generator, pneumatic ash-handling system, and accessory apparatus. Entire project estimated to cost $1,360,000. Proposed to begin work soon. Walter R. Crecelius is chief engineer.

Gibbstown, N. J. — Atlantic City Electric Co., Atlantic City, N. J., has approved plans for new steam-electric generating station on Delaware River at Gibbstown, with installation to include a 10,000-kw turbine-generator, high-pressure boiler, and auxiliary equipment. Increased capacity is scheduled in future. Initial plant is estimated to cost $6,500,000. Work will proceed at once. Burns & Roe, 233 Broadway, New York, N. Y., are consulting engineers.

Linden, N. J. — Rheem Mfg. Co., 570 Lexington Ave., New York, N. Y., steel drums, barrels, etc., plans boiler house at new plant at Linden, where 30-acre tract of land has been acquired. Initial unit will total about 150,000 sq ft floor space. Entire project reported to cost close to $1,500,000. Wigton-Abbott Corp., 1225 South Ave., Plainfield, N. J., is engineer and will supervise construction.

Medford, Ore. — California-Oregon Power Co., Medford, is arranging financing in amount of $6,000,000, through bond issue, fund to be used for construction and improvements, including generating facilities, transmission lines and miscellaneous work.

Harrisburg, Pa. — American Can Co., 100 Park Ave., New York, N. Y., plans boiler house at proposed new plant in vicinity of Harrisburg, where tract of about 48 acres of land has been acquired. It will consist of a main building, about 350,000 sq ft floor space, and several smaller structures, equipped for production of tin cans for food products service. Entire project reported to cost in excess of $2,500,000. Proposed to begin work soon.

Belton, Tex. — Rural Electrification Association, Belton, plans expansion in steam-electric generating plant, to form an additional production unit. Cost reported about $2,000,000, with high-pressure boiler, turbine-generator, and auxiliary equipment. Work is expected to begin in near future.

Dallas, Tex. — National Container Corp., 30–01 Review Ave., Long Island City, New York, N. Y., corrugated boxes and containers, plans boiler plant at new converting works at Dallas. Project will comprise a main production unit and several auxiliary structures. Cost reported about $600,000. Work will begin soon.

Fort Worth, Tex. — Texas Electric Service Co., Seventh and Lamar Sts., Fort Worth, is arranging financing through sale of bond issue, to total about $11,500,000, proceeds to be used for expansion and improvements in plants and system, including increased generating capacity, transmission lines and other operating facilities.

Longview, Tex. — Petrolite Corp., Ltd., Merchants Laclede Bldg., St. Louis, Mo., waxes, chemical specialties, etc., plans boiler plant at proposed new branch factory at Longview, where tract of about 85 acres of land has been selected. Project will comprise a main processing and production building, and several smaller structures. Proposed to begin work soon. Cost reported about $1,500,000.

Gilmerton, Va. — Virginia Electric & Power Co., Franklin and Seventh Sts., Richmond, Va., will begin work at once on foundations for proposed new steam-electric generating station, near Gilmerton, previously referred to in these columns. Installation will include turbine-generator units of 100,000-kw rating, high-pressure boilers, and auxiliary equipment. Completion is scheduled late in 1952. Cost reported close to $17,000,000. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer.

Spokane, Wash. — Washington Water Power Co., 825 Trent Ave., is arranging for financing in gross amount of $26,000,000 over a period of months, of which close to $19,000,000 will be used for expansion and improvements, including generating stations, transmission lines and other operating facilities.

Superior, Wis. — Superior Water, Light & Power Co., 1230 Tower Ave., has approved plans for expansion and improvements in local Winslow steam-electric generating station, with installation of equipment for increased capacity. Cost estimated about $1,400,000. Work is scheduled to proceed at once.

Union Grove, Wis. — State Dept. of Public Welfare, State Capitol Bldg., Madison, Wis., plans extensions in power plant at State Southern Colony and Training School, Union Grove, used for central-heating service. Installation will include new boiler, stoker, ash conveyor system, and auxiliary equipment. No estimate of cost announced. C. A. Halbert, State Capitol, noted, is chief engineer.

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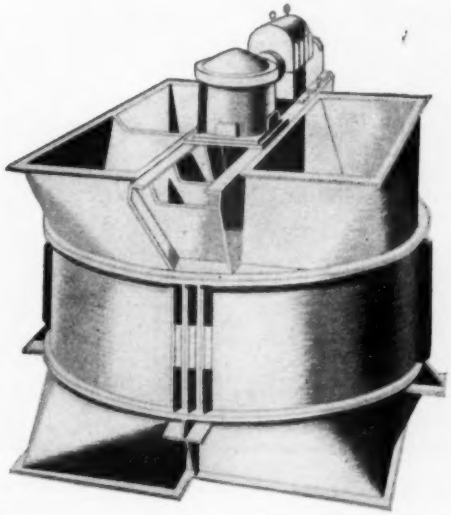
1. To improve combustion of low-grade fuels
2. To raise the level of heat recovery
3. To save materials in plant design

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.



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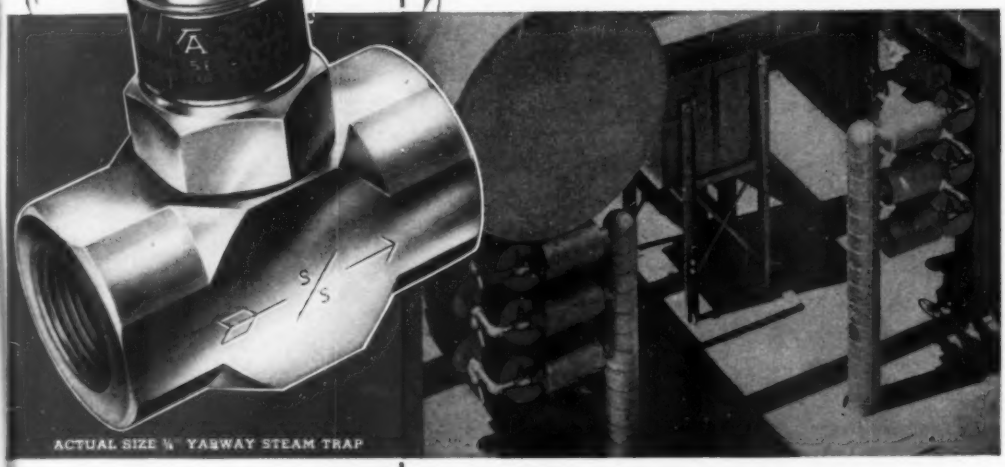

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LETTERS TO THE EDITORS

UNDERGROUND

YOUR ARTICLE in the December, 1950 issue referring to underground hydro plants needs the following addendum:

Mr. Lewin refers to Buchbergmuehle plant built in 1907 in Germany as the "first" underground hydro plant. That is not quite correct. The first plant was built right here in the United States and was a great deal larger than the plant referred to by Mr. Lewin. In 1907 there were hardly any hydro plants in Germany except small ones.

The first underground station was built 25 miles east of Seattle, Washington, had a head of 270 ft and a unit of 10,000 hp. The plant was built at Snoqualmi Falls in the years 1898–1899. Occasionally there is a good reason for such an arrangement here, as in the above case. In Norway and Sweden ice conditions make it often desirable.

Here, however, the necessary conditions are mostly absent, which is the reason why during the past 50 years no more have been erected. In Switzerland and Italy bomb-proofing is a big factor — steam plants are now built underground. Also, rocky gorges decide the economy.

The Snoqualmi plant is described in *Engineering News* March 29, 1906.

Austin, Texas — A. STREIFF

Water by Wishful Thinking

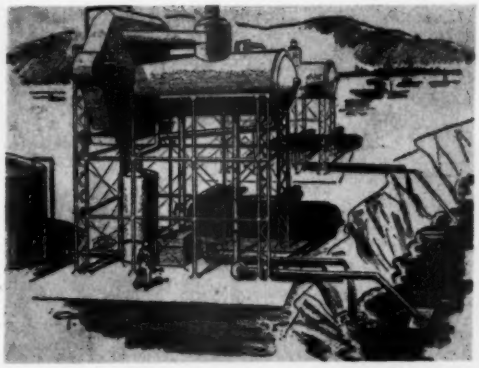
Editor's Note: — "Nature's miracle of boiling water with a vacuum instead of with a fire will solve the problem of giving this nation an inexhaustible supply of fresh water from the oceans." This is the conviction of a Los Angeles refrigeration engineer, and it is interpreted and explained in detail in the May 13, 1951 issue of the Los Angeles *Times*. According to the newspaper reporter's account, the engineer he quotes has a most ambitious plan for evaporating sea water in stills by producing a vacuum in them. Each still would contain two "boilers" each 17 ft in diameter and 40 ft long. A "small vacuum pump" would be needed to produce "the initial vacuum in the boiler." Leaks will be detected by recently developed "air detection devices harnessed to electronic controls to start the vacuum pump automatically and keep it going until the vacuum is restored."

Steam produced by these vacuum boilers would be condensed into fresh water and the salt and other substances discharged back into the ocean.

A pilot plant of 1250 gph capacity could be built for $75,000, says the engineer, but it would cost from $100,000,000 to $200,000,000 to build the 100 full-scale plants required to supply the 350 mgd now required by the city of Los Angeles.

The article gives much more explanation of the details of this vacuum distillation process, but it is not to be expected that in a newspaper account of it, the details can be made clear in a technical sense. Certainly they are not clear to us.

However, because of the very real water supply problem in that part of the Pacific Coast and the concern of the general public in its solution, our good friend, C. O. Sandstrom, has been moved to offer the following comment on it.



Artist's conception of proposed vacuum stills for producing fresh water from ocean water at Los Angeles

Editor's Note: — A "fan" or blower is supposed to produce 29.3 in. Hg vacuum in these stills. Also notice the simple water intake and discharge. How about clogging of those passages with marine growths, as discussed at length in the technical literature? Also what kind of a "fan" would be required to produce 29 in. of vacuum? Also . . . but we give up!

Readers will remember that we published a letter from him in our May 1949 issue under the title Water Shortage. At that time he called attention to the many schemes being proposed to make fresh water out of ocean water for Los Angeles, which at that time was short of water because of the droughts in California.

One method proposed was to use multiple-effect evaporators. He pointed out that none of the proposed plans could be carried out at little cost. The non-engineering public, seeing the whole Pacific Ocean only a few miles away, is always ready to be impressed by the idea that with all that water "there ought to be some way to get the salt out of it so you can drink it." Just why this seems so logical to most people is hard to explain. There are ways, but at tremendous cost.

But hear Mr. Sandstrom again.

WATER SUPPLY MAGIC

"A LITTLE LEARNING is a dangerous thing;
Drink deep, nor taste the Pierian spring!"

said a poet more than 200 years ago. If he were alive today he might be referring to the many schemes that have been proposed for rendering seawater fit for domestic use in Southern California. It has been remarked that though this land is a pleasant place in which to live, we may some day die of thirst.

In the Los Angeles *Times* of May 13 is an illustrated article describing the latest brainstorm on the subject. It is proposed to install along the coast as many units of 3,500,000 gpd capacity as is thought needful, up to the entire water consumption of the Metropolitan area of about 350,000,000 gpd. It was asserted that potable water could be produced at a cost of 5 cents per ton; that a "pilot-plant" of 30,000 gpd could be erected for $75,000; and the 100 plants to produce the total requirement of 350,000,000 gpd would cost from $100,000,000 to $200,000,000.

The tenor of the article was, "boiling water with a vacuum instead of costly heat." A vacuum is to do the work of heat. But since a vacuum is merely a space devoid, or nearly devoid, of pressure — in other words, a *nothing* — it isn't clear how this nonentity can do anything!

In none of the schemes proposed over the past several years did the advocates appear to have the faintest idea of the quantities involved. And everything was to be had at "little cost." Of course, these "little costs" were to be borne by city, county, state, or Federal government. Anybody with the idea *and* the money could be expected to go ahead with a minimum of discussion.

In the present scheme it is proposed to utilize the low-temperature heat of sea-water for self-evaporation; a result to be attained by reducing the pressure above the water to its boiling point. A water temperature of 65 deg. was assumed, at which temperature the vapor pressure would be about 0.3 psia, or a 29.3 in. vacuum. Since a large capacity is hoped for, the pressure difference must be increased. But, as there is only 0.3 lb. available to a perfect vacuum, not much can be expected in that direction.

Following is the description of the plant: "Each of 100 stills would contain two boilers, a single one of which would measure 40 feet in length and 17 feet in diameter. The fan used to move the steam from both boilers would measure 30 feet in diameter. The distance from ocean level to the motor dome above the fan would be more than 50 feet. The output of each of the 100 twin boiler units would be 3,500,000 gallons of pure water daily." Also this: "A dome above the boiler contains a blower fan which helps maintain the circulation by moving the steam into a device which causes cooling. The steam ultimately passes into open-ended condensation tubes placed in the boiler. Inside these tubes the

(*Continued on page 122*)

Improved Penstocks Reduce Costs

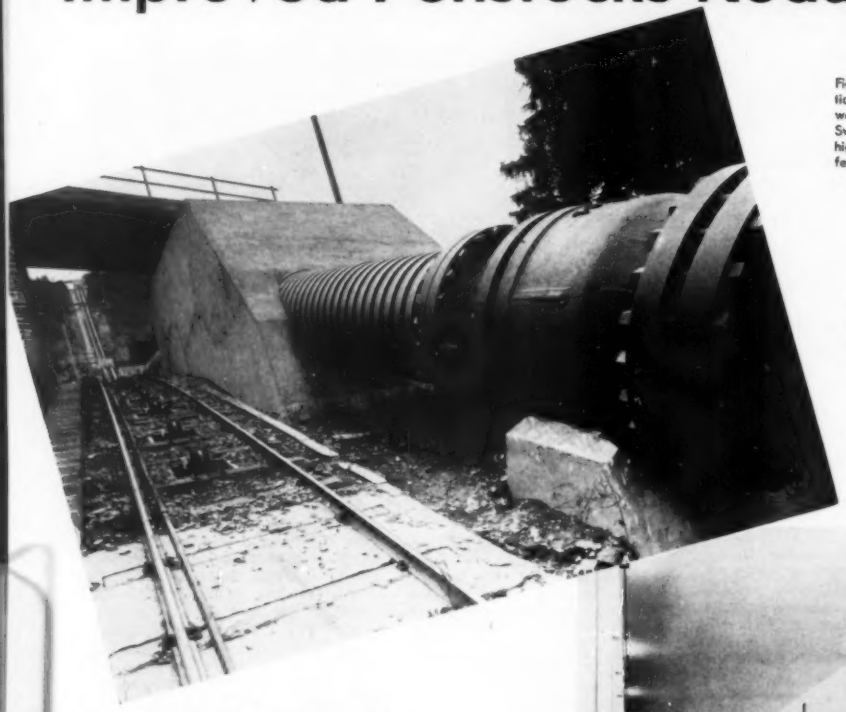


Fig. 1 (Left). A close-up of a portion of the penstock delivering water to the Dixence plant in Switzerland. This is the world's highest head hydro plant—5740 feet. As can be seen, this is a solid steel ring reinforced penstock

All photographs on this page furnished by the manufacturers of the penstocks, Acciaieria E. Tubificio Di Brescia of Brescia, Italy

Fig. 2 (Below). View of the Dixence hydroelectric plant in Switzerland showing the lower portion of the 5740 ft head twin penstocks leading to the power plant. A close-up of this penstock is shown in Fig. 1

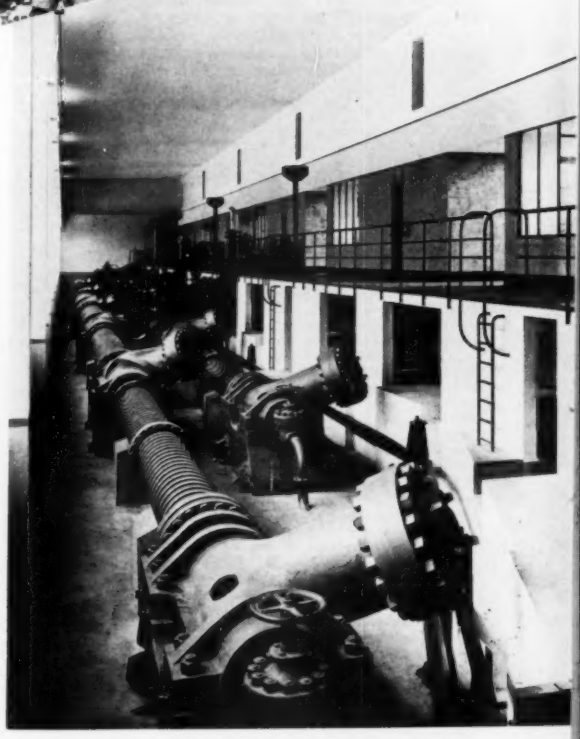


Fig. 3 (Above). Interior view of the Dixence Power Plant showing the connections to the high-head turbines

For High-head Hydroelectric Plants

Remarkable progress in the design and construction of pressure pipe has greatly extended the capabilities of penstocks for hydroelectric power plants. Today, the fittings rather than the pipe are the limiting factor. As shown by the author it is no longer possible to construct fittings which will handle the power that can be delivered to them. Modern penstock construction is described and a number of European and American installations provide typical examples

By GEORGE A. WHETSTONE

Associate Professor, Department of Civil Engineering, Texas Technological College, Lubbock, Texas

THERE ARE certain basic differences between high-head and low-head hydroelectric developments. These may be traced to the physical necessities of handling high pressures in the one case or large discharges, with correspondingly large storage facilities, in the other. This basic distinction is a consequence of the power relation

$$\text{horsepower} = \frac{QwH\eta}{550} \qquad (1)$$

where Q: discharge in cubic feet per second,
w: specific weight in pounds per cu ft (= 62.4),
H: head in feet, and
η: efficiency.

The problems of the low-head development are most likely to be those associated with large storage and with multiple-use since, when large quantities of water are involved, power is often incidental to some other purpose. On the other hand, a high-head plant is seldom part of a multiple-use development since the discharges involved are moderate and

Fig. 4 (Above). Penstock of L'Arvan, French Alps. Head 1892 ft. Penstock diameter, 4.25 ft. Discharge, 212 cu ft per sec. (Photo, courtesy, Bouchayer et Viallet)

Fig. 5 (Left). Penstock of Aussois, French Alps. Head 2860 ft. Penstock diameter 5.4 ft. Discharge 423 cu ft per sec. An interesting feature of this development is that the penstock branches at the bottom. Through one branch the water can be used in a conventional hydroelectric power plant. Through the other branch the water is used to drive two 55,000-hp impulse turbines each direct connected to a centrifugal fan in the experimental wind tunnel of the French Government's Aeronautical Research Laboratory. (Photo, Bouchayer et Viallet)

the setting is necessarily mountainous. The problems of a high-head development are usually those of getting the water to the powerhouse and of getting the electricity to market.

Barrows [1] has cited the following percentage costs for seven plants having an average head of 1550 ft and a range in head of 1050 to 2561 ft: dam 9 per cent, waterway 61 per cent, powerhouse 26 per cent, highways 2 per cent, and land and water rights 2 per cent. The term waterway may include flumes, flowlines, tunnels, and penstocks, where by penstock we mean the pipeline from the last open water (or forebay) to the powerhouse. Pipe upstream of the forebay, and thus low-pressure, is classified as flowline.

Historically, the penstock has been the limiting factor in high-head developments. A head of 2300 ft will produce a static pressure of 1000 pounds per square inch (psi). Due to water-hammer about another 15 per cent must be allowed to get the working pressure at the lower end of the penstock. Thus in round figures we may say that the working pressure in psi is half the head in feet.

Pipe to hold such high pressures as those of Bissorte (France) 3800 ft, Le Portillon (France) 4640 ft, or Dixence (Switzerland) 5740 ft is not only expensive, but it provides a challenge to technical knowledge and skill. As an example, let us apply the usual pipe stress formula of the strength of materials texts

$$\frac{t}{r} = \frac{p}{S_t} \qquad (2)$$

where t is the wall thickness, r is the internal radius, p is the internal fluid pressure, and S_t is the allowable tensile stress in the pipe walls, to the head at Dixence, taking 20,000 psi as a reasonable value for S_t for steel pipe. Then

$$\frac{t}{r} = \frac{2870}{20000} = 0.1435.$$

For this head a 48-in. pipe, which is moderate for a penstock, would require a wall thickness of 3.444 inches. How is this to be fabricated or to be erected on a mountainside even if we could justify the costs?

Several methods of responding to this challenge of high pressure have been employed.

1. Such sites can be avoided. The same or some other stream may present a low- or medium-head site where dam and water right problems can be substituted for those of pressure pipe. And we must remember that hydro economics is always basically governed by competitive fuel costs.

2. The head may be developed in steps. Development in steps is common practice in this and foreign countries. Thus at Big Creek, California, part of the water is utilized under successive heads of 2131 ft, 1858 ft, 715 ft, and 830 ft while other water is employed successively through 2418 ft, 715 ft, and 830 ft.[2] While the economics of step development does not depend entirely on penstock considerations, these have played a most important part.

3. Several parallel penstocks may be used. It will be shown that for the same coefficient f, and the same penstock head loss (or, what amounts to the same thing, the same penstock efficiency) discharge varies as the 2.5 power of the diameter. Thus, starting with the Darcy-Weisbach expression

$$h_L = f \frac{L}{D} \frac{v^2}{2g} \qquad (3)$$

where h_L: lost head in feet (actually foot-pounds per pound,
L: pipe length in feet,
D: pipe diameter in feet,
v: water velocity in feet per second, and
g: 32.2 feet per second, per second:

and substituting $Q = Av = 0.785 D^2 v$, we have

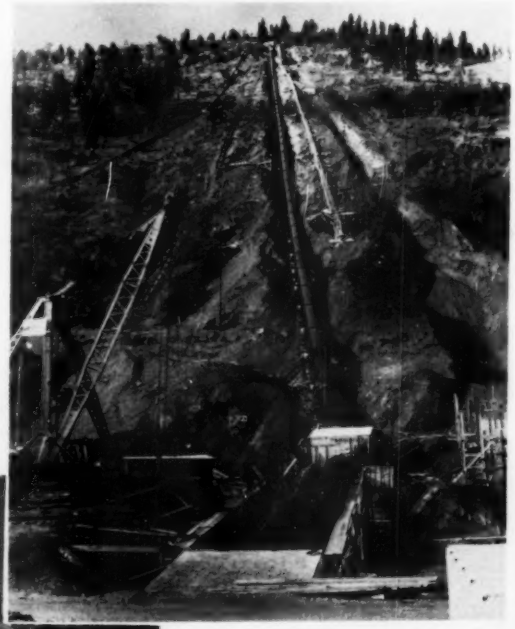


Fig. 6 (Above). Penstock of the Bridge River plant of British Columbia Electric at Shalalth, B. C. This penstock, recently placed in operation (see *Power Engineering*, page 104, May 1950 issue) supplies three 6-jet vertical Pelton wheels, all rated at 50,000 kva and operating under 1117 ft head. The penstock is 75½ in constant outside diameter. (Photo, British Columbia Electric Co.)

Fig. 7 (Left). Erecting the Bridge River penstock. The erection was facilitated by the use of the portable erection frame shown in Fig. 8. (Photo, British Columbia Electric Co.)

Fig. 8. This is the portable erecting frame used in erecting the Bridge River penstock of the British Columbia Electric Co. This frame travels on rails on each side of the penstock

$$h_L = f\frac{L}{D}\frac{Q^2}{(0.785)^2\,D^4\,(2g)}$$

or $$\frac{Q^2}{D^5} = \frac{(0.785)^2\,2gh_L}{fL},$$

a constant. (4)

Thus using the Dixence head example again but limiting arbitrarily the wall thickness to one inch, we would have a corresponding internal diameter given by D/48 = 1/3.444, or D = 13.94 in.

$$\text{Then } \frac{Q_1}{Q_2} = \left(\frac{48}{13.94}\right)^{2.5} = 22.0$$

In words, we could replace our 48-inch penstock with the 3.444-in. walls by 22 13.94-in. penstocks with 1.00-in. walls.

As a further consequence of equations (4) and (2) we have

$$\frac{Q^2}{t^5} = \frac{Q^2}{D^5}\left(\frac{D^5}{t^5}\right) = \frac{Q^2}{D^5}\left(\frac{2\,S_t}{P}\right)^5,$$

a constant. (5)

Thus for the same discharge through one pipe with dimensions D_1 and t_1 or n pipes with dimensions $D_2 = D_1\,(Q_2 \div Q_1)^{2/5} = D_1\,(1 \div n)^{0.4}$ and $t_2 = t_1\,(1 \div n)^{0.4}$ the corresponding weights per running foot of penstock will be $W_1 = \gamma\,\pi\,(D_1 + t_1)\,t_1$ and $W_2 = \gamma\,\pi\,(D_2 + t_2)\,t_2 n$, where γ is the weight of the pipe material in pounds per cubic foot and D+t is the average diameter of the pipe material. Thus the ratio of total weights per foot is

$$\frac{W_2}{W_1} = \frac{n(D_2 + t_2)t_2}{(D_1 + t_1)t_1} = n\left(\frac{1}{n}\right)^{0.4}\left(\frac{1}{n}\right)^{0.4} = n^{0.2}.$$

For our example $n^{0.2} = \sqrt[5]{22} = 1.86$.

This apparent law giving the ratio of total weights as the fifth root of the number of pipes is actually subject to some valid and damaging criticism. The most important point may be seen by glancing at a table of coefficients f as a function of pipe diameter and velocity. Larger pipe has smaller values of f for the same velocity. For the same size pipe f decreases as the velocity increases.

From equation (4) and the law of continuity we have

$Q = k_1 D^{5/2}$, and $Q = Av = k_2 D^2 v$.

$$\text{Thus } \frac{Q_1}{Q_2} = n = \left(\frac{D_1}{D_2}\right)^{5/2} = \left(\frac{D_1}{D_2}\right)^2 \frac{v_1}{v_2},$$

$$\text{whence } \frac{v_1}{v_2} = \left(\frac{D_1}{D_2}\right)^{1/2} = n^{1/5}.$$

That is, for the same head loss and the same total discharge the velocity in the large pipe is $n^{0.2}$ times that in a small pipe. Thus, far from having the same f as assumed in deriving the fifth-root law, the f for the large pipe is much less than for a small pipe.

Taking Scobey's[3] values of f and a few sample values from our example we have, since $v_{14} = v_{48} \div 22^{0.2}$

velocity in 48" pipe (v_{48})	velocity in 14" pipe (v_{14})	f_{48}	f_{14}	$\frac{f_{14}}{f_{48}}$
3 fps	1.61 fps	0.0160	0.0219	1.37
6	3.23	0.0145	0.0195	1.35
10	5.38	0.0135	0.0181	1.34
15	8.07	0.0125	0.0170	1.36
20	10.76	0.0120	0.0164	1.37

Thus without pursuing detailed calculations it is evident that the excess steel requirement for multiple pipe lines exceeds the fifth-root ratio.

Excess steel is not the only objection to the parallel penstock solution. More excavation and more concrete are involved as well. On the other side of the ledger it is sometimes an advantage to have one penstock per turbine or pair of turbines to avoid bifurcations and reduce the number of valves.

4. We may employ a better class of pipe. As examples of what has been done in recent years in this direction we may cite the plants of Eget, France, developed in 1913 with seven parallel penstocks weighing 2450 tons, and redesigned in 1941 with a single penstock weighing 620 tons, and Bissorte, France, designed in 1922 with eight parallel penstocks weighing 7700 tons, and redesigned in 1945 with a single penstock weighing 1350 tons.

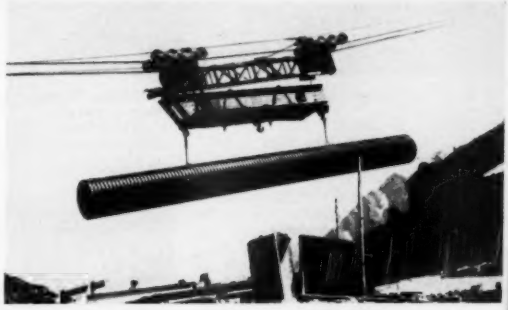


Fig. 9. Transporting a length of pipe for the Portillion penstock. This plant in the French Alps develops the highest head in France—4640 ft. The penstock varies in diameter from 3.94 to 2.62 ft. (Photo, courtesy Bouchayer et Viallet)

This reduction in weight has been accomplished by three improvements in pipe fabrication — the development of expanded pipe, of reinforced pipe, and finally of reinforced expanded pipe.

Expanded Pipe

Expanded pipe is essentially welded pipe made from a grade of steel well adapted to welding which has subsequently had its properties improved by cold-working. Referring back to formula (2) we are reducing t by increasing S_t.

The process of construction is about as follows. The pipe is arc-welded to a diameter a predetermined amount less than the final desired diameter. It is then inserted in a mold, the internal dimensions of which correspond to the external diameter of the finished pipe. Pipe and mold are placed in a hydraulic press and water pressure is applied to expand the pipe beyond its elastic limit into contact with the mold.

After removal from the mold the

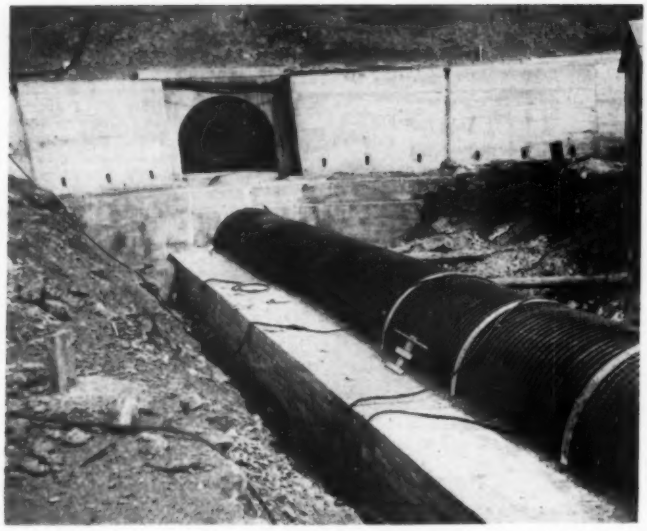


Fig. 10. This is a view of the lower part of the penstock at L'Arvan. This is a penstock of the reinforced cable type. (Photo, Bouchayer et Viallet)

expanded pipe has a new elastic limit equal to the maximum stress it underwent in the process. Many experiments have shown that this cold-working process has not rendered the steel brittle, fragile, or heterogeneous. In short, no dangerous properties are induced.

The factor of safety based on the ratio of internal pressure at the elastic limit to normal service pressure is automatically determined in the construction of the pipe.

In French practice a plate may have as elastic limit 48,300 psi in the original state, 56,800 psi with 2 per cent elongation, and 71,000 psi with 5 per cent elongation. For a fixed pressure if the weight required in an unexpanded pipe be taken as K, the corresponding weights for 2 per cent and 5 per cent expansions would be 0.85K and 0.68K respectively.

Expanded pipe is familiar in American petroleum practice since nearly all line pipe now on the market is made by this process. Some of our manufacturers have developed welding machines with a million-ampere arc which will weld a forty-foot length of pipe simultaneously using only the parent metal of the plate for the weld. A predetermined amount of excess steel containing the oxides formed by heating is squeezed out during the welding and then removed by trimming, leaving a clean, sound, strong seam. The subsequent cold-working expansion in a hydraulic press increases the yield strength from an orginal 42,000 psi to at least 52,000 psi.

Reinforced pipe, also known as prestressed pipe or as auto-fretted pipe, consists essentially of a thin welded tube surrounded by either rigid bands, cable in individual slings, or cable wrapped helicoidally.

The simplest, but least effective, method of reinforcing a pipe is by the employment of stiffeners. These are rigid rings, usually angles, welded or riveted around the outside of the pipe. Neither plate nor band carries any intentional stress.

Another method of some years standing known as the Ferrum process consists of heating the rings before slipping them on the pipe. By adjustment of the cold ring size calculable compressive stress can be induced in the tube when the ring cools. The rings, of course, are in tension even with no pressure in the pipe. As the pipe comes under internal pressure the plate stress is first relieved then brought up to its working strength in tension. The rings in the meantime undergo a change from the tension in their unloaded condition to the much higher tension under load. For the system to be effective the rings must have a higher elastic limit than the plates, but this is hard to maintain through the heating to expand the rings so they will slide on in the first place.

Individual cable slings may be applied to a pipe. In a process used to reinforce pipe in place a sling is looped over two shoes which are fastened at each end of a turnbuckle arrangement. By closing the gap between the shoes the cable is stretched and the pipe wall compressed.

Finally, cable may be rolled on under initial tension. This process was developed and perfected in the ordnance industry where the coils are closed and there may be, in fact, several layers of cable. On penstocks the coils are spaced with the spacing dependent on the pipe line pressure. It is, of course, necessary to anchor the cable every few feet so that a single break will unroll only a few turns. The usual French specifications when using this type of pipe call for a factor of safety with respect to the elastic limit of 2.5 for the reinforced pipe and also for a factor of safety slightly greater than unity for the plate alone. We shall return to the subject of cable reinforcement later.

Reinforced Expanded Pipe

Having expanded pipe and reinforced pipe, it was an obvious step to combine the processes. This has produced outstanding results. While much experimentation continues and while the various types of reinforcement — rigid, cable in individual slings, and helicoidally wrapped cable — have no universally accepted order of preference, it has been well established that expanded reinforced pipe is the ideal answer to the demand for light-weight high-pressure pipe.

Following chronological order we may consider first the rigid hoops. No longer are these expanded by heating with the resulting damage to the steel properties. They are now made in laminations, like a bandage, of steel with an elastic limit of 85,000 to 135,000 psi. They are slipped over the pipe cold and the pipe is then expanded on a hydraulic press. The original elastic limit of the plate is exceeded, it expands to contact with the hoops, and then both expand together a determined amount, the expansion of the hoops being, however, within their elastic limit.

During the war when steel was nearly impossible to obtain an attempt at even greater economy in metal was made by using flexible cables rather than rigid hoops for the reinforcement. This was first done on the penstock of Veneon (1250 ft head, 530 cu ft per sec) in 1943. The inducement was obvious. The ultimate strength of steel bands has not been raised beyond about 165,000 psi. On the other hand, cable has been made with an ultimate strength of 285,000 psi and an elastic limit of 213,000 psi.

In the course of the studies leading to the adoption of cable an extensive testing program was carried on. The principal conclusions were

a. The cable can be made noncorrdsive by galvanizing at the first pass in wire drawing. The further passes then force a bond between zinc and steel which has remained unbroken through rubbing, hammering, and crushing tests which have deformed the wire.

b. The possibility of damage in transport and erection and, in particular, of collapse under an accidental internal vacuum seems very

real when we consider that the plate alone would not support a vacuum and that the bands are flexible. Extensive tests have shown, however, that the pipe is stable under these conditions.

c. The strength of cable-wrapped pipe against shock due to falling rock hitting an exposed penstock received a severe test when a slide of large blocks of gneiss occurred while the Veneon penstock was under construction. The bands protected the plates completely and suffered only a few bruised strands themselves. The damaged slings were easily replaced in the field. It is evident that individual slings would cause less concern than would spiral wrappings. In fact, in 1946, it was expressly required that spiral wrapped pipe be buried or placed in galleries. Since then, however, new processes of anchoring the spiral every few turns have been perfected and present practice permits use of helicoidal reinforcement on exposed penstocks.

d. Despite the small areas of contact between cable and plate, little loss of strength results from lateral crushing.

e. Cable-wrapped pipe may be protected by encasing the pipe in concrete. This is done after first bringing the pipe up to working pressure so that under smaller pressures the concrete will be in compression.

5. Two other developments of significance for penstocks should be mentioned.

First, it is increasingly common practice to place the penstock in a braced gallery thus allowing the gallery walls to participate in the stress. This also preserves the advantages of both buried construction (better alignment, protection from shock, smaller temperature variations, less interference with roads) and exposed construction (better inspection and maintenance).

Second, the trend to underground powerplants [4] derives much of its economic justification from the fact that the penstock is replaced by a vertical shaft in the rock. It is interesting to note that these shafts are often lined with prestressed concrete.

An indication of the progresss realized in pressure pipe may be seen in the following figures quoted by Ferrand for the maximum power deliverable in a single penstock.

1922	30,000 hp
1932	120,000 hp
1946	240,000 hp
1949	No longer meaningful. It is not now possible to construct fittings which will handle the power which could be delivered to them.

Acknowledgements

The material on French practice in this paper was largely obtained from the following articles:

FERRAND, G.: The Single Penstock for High Heads with Great Power (La Conduite Forcee Unique pour Hautes Chutes a Grande Puissance). La Houille Blanche vol. 1, pages 245–255, 1946.

FERRAND, G.: The Aussois Development. Tests on Pipes Reinforced with Cable (Chute d'Aussois. Essais sur Tuyaux Autofrettes a Frettage Souple). La Houille Blanche vol. 2, pages 169–184, 1947.

FERRAND, G.: New Trends (Les Tendances Nouvelles). La Houille Blanche vol. 4, pages 230–240, 1949.

BEAUMEL, M. H.: The Penstock of the Pralognan Development (La Conduite Forcee de la Chute de Pralognan). La Houille Blanche vol. 5, pages 131–143, 1950.

The author wishes to express his sincere thanks to L'Etablissements Bouchayer et Viallet, Grenoble, France and to the British Columbia Electric Railway Co., Ltd., Vancouver, B. C. for their generosity in supplying photographs and data.

This paper is a revision of a paper entitled *Modern Developments in High-Pressure Pipe* presented by the writer at a joint meeting of the Texas Sections, Petroleum Branch, American Institute of Mining and Metallurgical Engineers, at Lubbock, Texas December 2, 1950.

Fig. 11 (Above). The Aussois penstock. This pipe is reinforced with rigid steel bands. This project develops a head of 2860 ft, and as explained under Fig. 5, combines a hydroelectric plant with an aeronautical testing laboratory. (Photo, Bouchayer et Viallet.)

Fig. 12 (Right). View showing the anchorage of a bend on the penstock of Sept-Laux in the French Alps. (Bouchayer et Viallet)

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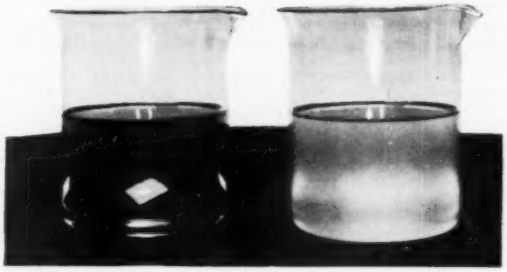

Figure 1. Sludge Dispersion. Both beakers contain the same amount of calcium phosphate sludge. The clear solution in the beaker on the left contains in addition 100 ppm of dispersive

Using and Misusing Organic Water Conditioning Materials

Most troubles due to hard scale in boilers have been overcome by external water softening and internal treatment with phosphate chemicals. In some boilers, however, a new problem has come up. Instead of a hard scale, a much softer material, called sludge, may be present in the boiler tubes. This sludge may become so heavy that the tube will eventually block and burst. The addition of organic materials will keep the sludge suspended in the water and in some cases this method of treatment has worked very well. However, in other cases the addition of organic material has caused more harm than good. The boiler water may foam or the material may break down and cause a deposit of scale itself. Knowing when and when not to use this type material is a matter of experience and engineering know-how

THE PROBLEM of hard scale in the boiler has been largely eliminated by improved softening and the use of internal inorganic water conditioning chemicals. With properly controlled phosphate treatment, for example, carbonate and sulfate scales will not be present. In many cases, however, where this hard scale has been eliminated, the presence of sticky sludge has received considerable attention. This situation has been aggravated by the high capacity units which have become popular in recent years.

A number of different attacks, both mechanical and chemical, have been made on this problem. Among these may be mentioned improved boiler designs to increase circulation and mixing of feed and boiler water, improved softening, closer phosphate control, higher alkalinity, use of silica, and the use of organic materials. The use of the last-mentioned organic materials is based chiefly on their ability to disperse sludge or at least make it less adherent. Sludge ordinarily consists mainly of calcium phosphate and magnesium silicate. These two major constituents are usually accompanied by varying amounts of magnesium phosphate and iron oxide and small amounts of other materials. A typical sludge deposit analysis is shown in Table 1.

Tannins, lignins, and other organic agents possess to a varying degree the ability to disperse or fluidize such a sludge. They are particularly effective in dispersing calcium phosphate sludges, while most of them are not nearly so effective in dispersing sludges that contain appreciable amounts of magnesium and iron compounds.

The use of organic materials as boiler water conditioning agents is usually dependent upon four effects which they produce. The relative magnitude of each of these under boiler water conditions limits the usefulness of the particular material and determines whether the results produced will be beneficial, neutral, or harmful. These effects of organic boiler water conditioning agents are: first, the above-noted ability to disperse sludge; second, the ability to flake off scale and sludge; third, the tendency to foam; and fourth, the tendency to decompose. These tendencies or properties may vary greatly from one material to another.

These properties are illustrated in the accompanying photographs. The material for most of these figures has been obtained by laboratory experiment for clarity of illustration. While the conditions of these experiments are considerably different from those which prevail in actual boilers, our experience indicates that the experimental observations will at least approximate the results obtained under boiler operating conditions.

Sludge Dispersion

Figure 1 illustrates the dispersion of sludge. Light is passed through the beakers from a diamond-shaped aperture in the rear. Both beakers contain 100 ppm of calcium together with amounts of caustic and phosphate sufficient to give a calcium phosphate sludge and still leave residual phosphate and alkali which would normally be present in boiler water. Both had been heated to boiling and were still quite hot when the picture was taken. The only difference was that 100 ppm of a modified

Material for this article was taken from a paper by Robert W. Liddell and Louis C. Bishop, Hall Laboratories, Inc., Pittsburgh, Pa. Portions of the paper were presented at the 1951 Midwest Power Conference, Chicago, Illinois.

lignin was present in the left-hand beaker. In the beaker containing no dispersive a typical heavy suspended sludge may be noted. This sludge is so dense that only a small amount of direct light comes through the solution from the aperture, most of the light being diffused. Note the beaker to which the lignin was added, where — even with the thermal agitation — the aperture is quite clearly outlined. The lignin disperses the calcium phosphate sludge so well that no particles are visible. While a Tyndall cone may be seen under the proper conditions, the sludge is still so finely dispersed that it will pass readily through a No. 42 filter paper.

In Fig. 2 are shown the same solutions when poured into liter graduated cylinders. The sludge in the untreated cylinder has begun to settle while the solution containing the lignin-treated sludge remains clear. This latter figure illustrates very well the ideal behavior of an organic boiler water conditioning agent. It shows the normal behavior of untreated sludge which may settle out and deposit in the boiler, while the ideally dispersed sludge does not have this tendency. Under actual operating conditions, the presence of other materials less readily dispersed than calcium phosphate, such as magnesium compounds and iron oxide, as well as decomposition of the organic dispersing agent will make this ideal condition difficult if not impossible to obtain throughout the boiler.

Table 1. Sludge Deposit from Steam Drum of 430 Psi Boiler

CHEMICAL (Semiquantitative—rounded to nearest per cent)

	Per Cent
SO_3	1
CO_2	no evidence
P_2O_5	22
SiO_2	15
Fe_2O_3	12
Al_2O_3	1
CaO	27
MgO	14
Cu	1
Net ignition loss (corr.)	7
Oil	negligible

SPECTROSCOPIC

Major: Ca, Si, Fe, Mg
Low Minor: Cu, Al, Zn
Trace: Ti, Sr, Ba, Mn

X-RAY—Sample ignited to 1000 C

Major: Tricalcium phosphate and hydroxyapatite
Minor: Maghemite, hematite, and forsterite

MICROSCOPIC

Major: Calcium phosphate, finely divided and in clumps
Low Major: Large plates of magnesium silicate containing iron and possibly organic material
Low Minor: Complex silicate resembling hornblende

Calculated Composition

	Per Cent
Tricalcium phosphate and hydroxyapatite	50
Magnesium silicate	32
Iron oxide	12
Aluminum silicate (complex)	2
Copper	1
Net ignition loss less combined water	2

Appearance: Soft gray brown chips

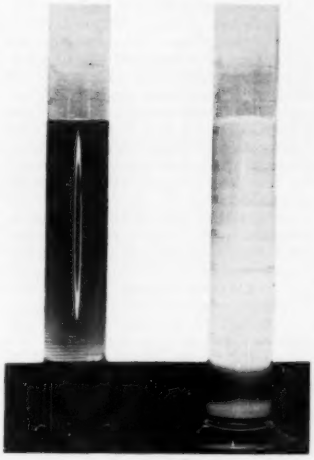

Figure 2. Sludge Dispersion. The solutions in Figure 1 have been poured into graduated cylinders. The sludge has begun to settle in the untreated cylinder. Note that the solution containing the tannin is so clear that the lines on the back of the cylinder may be plainly seen

Flaking of Deposits

Figure 3 illustrates the second important property of organic conditioning agents: namely, the ability of certain organic agents to flake off sludge and scale. A water containing 6 grains of bicarbonate hardness was evaporated to about 25 concentrations by means of a laboratory immersion heater. The solution was allowed to cool, the concentrated solution run out, replaced with fresh feedwater, and the heater again turned on. Most of the scale remained tightly adherent to the heater which is shown on the left. To an identical water 10 ppm of a tannin-type dispersive was added. The results are shown in the right-hand pictures. A part of the material shown at the extreme right flaked off during the evaporation and another part came off during the cooling process. However, the major portion flaked off during the reheating period. This laboratory experiment was conducted with a calcium carbonate scale under conditions which would correspond most nearly to a very low pressure heating boiler using a carbonate type of conditioning. Nevertheless, when organic treatment is used in boilers which are phosphate treated, an analogous behavior is often noted. The sludge deposits become thinner and more brittle, and have a greatly increased tendency to flake off and then may collect in the drums and headers.

This experiment also illustrates the other thing often noted, namely, that although the headers, drums, and the visible portions of the tubes may appear fairly clean when opening the boiler, tube failures may often follow within a few days after again putting the boiler on the line, due to the flaking off of sludge on reheating with subsequent blocking of tubes and headers. With certain types of boilers, this flaking-off behavior may be desirable, but in most units it is preferable to employ some inorganic treatment, with or without an organic material, to disperse the sludge or scale formers rather than merely make them more likely to peel off once they have deposited.

Foaming

Figure 4 illustrates the tendency of certain dispersives to aggravate foaming conditions. The photograph on the left shows the foaming produced in a laboratory tester by a water containing 2500 ppm of dissolved solids and several hundred ppm of sludge. The center photograph shows the same water to which had been added 100 ppm of a modified lignin-type dispersive. This clearly shows the increased foam brought about by this material. The photograph on the right shows the ability of 1 ppm of a suitable antifoam to not only get rid of the excess foam caused by the dispersive, but also to diminish somewhat that caused by the solids in the original water. These photographs illustrate that dispersives may aggravate foaming and that antifoams may be used as palliatives for this condition. It is conceivable, however, that conditions may arise which will make the antifoam less effective, and for this reason *an ideal boiler water conditioning agent should not have the tendency to increase foaming.* On the other hand some dispersives actually seem to have the property of correcting certain foaming conditions.

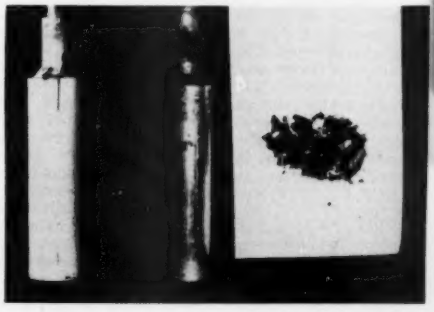

Figure 3. Flaking of Deposits. Calcium carbonate scale has deposited on the heater on the left. By adding 10 ppm of dispersive to the same feedwater, the scale shown on the right flaked from the hotter portions of the right-hand heater

The fourth important property of organic agents is their stability or lack of stability under operating conditions. In cases where the dispersive decomposes to soluble or dispersible materials, this decomposition should prove to be relatively harmless. However, under conditions where there is a tendency for it to be dragged out by the sludge, to be deposited by a high rate of evaporation or to undergo marked breakdown to insoluble products in a concentrating film, considerable harm may result. Under the very severe conditions imposed by certain units it seems logical to suppose that no organic water conditioning material may remain completely stable. Table 2 shows the analysis of a deposit obtained in a high pressure, highly rated boiler which was being treated with an organic material recommended for high pressure operation.[1]

Table 2. Deposit Containing Carbonaceous Decomposition Products

	Per Cent
SO_3	negligible
CO_2	absent
P_2O_5	5.1
SiO_2	1.9
Fe_2O_3	53.3
CaO	1.5
MgO	5.1
Cu	8.9
NiO	0.6
ZnO	negligible
Carbon	21.59
Hydrogen	0.88
Total Ignition Loss	20.1
Net Ignition Loss (Calc.)	24.3[2]
Fe_3O_4	considerable
Oil	no evidence

Deposits prior to and following the use of this material have showed only small ignition losses, usually from 1–2 per cent.

It should again be emphasized that the different organic water treating materials vary considerably in all of the properties discussed. It also appears likely that they will be considerably improved so that their ability to disperse sludge will increase and that any tendency to increase foaming will be eliminated. The ability to remain stable under any operating conditions to which they may be subjected will probably be the most difficult problem to overcome.

While experiments under relatively simple and reproducible conditions may readily be conducted in the laboratory, this simplicity disappears under actual boiler operating conditions. Since the true test of theories or materials is their applicability to actual conditions of use, the behavior of the organic materials under the exceedingly complex conditions encountered in the boiler is the really important factor.

A well-operated plant had five 200 psi boilers and two 400 psi boilers. Four of the 200 psi boilers were rated at 500 hp and were of the 2-long-drum type while the other was an 800 hp unit of cross drum construction. Feedwater was about 50 per cent condensate and 50 per cent cold lime-soda softened. Phosphate conditioning gave very good results with no tube ruptures or harmful sludge accumulations.

One of the 400 psi boilers was a 100,000 lb per hr unit of the 2-drum bent tube type with economizer and water walls. While the tubes in this boiler did not actually rupture due to sludge accumulation, occasionally several of the side wall tubes would blister due to this condition. The second 400 psi, 150,000 lb per hr boiler was a conventional 4-drum Stirling type (no water circulators between the middle and rear drums) with water walls. With this boiler, excessive sludge accumulation was quite a problem. When first examined the sludge was of a slimy consistency and could be readily wiped away by the finger down to the bare metal. After drying it would change to a chalk-like consistency but was still soft and friable.

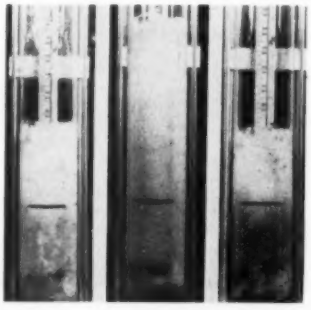

Figure 4. Foaming of Organic Dispersives. Left—foaming of boiler water. Center—same water to which 100 ppm of a dispersive has been added. Right—same solution as in center treated with 1 ppm of antifoam

Even though this sludge was evidently soft and slimy in the boiler under operating conditions, it still caused considerable trouble. This trouble was largely localized in the downcomers from the rear drum and in the water walls and water wall headers. It was noted that the deposit was much heavier on one side of the boiler than on the other, indicating poor mixing of the feed and boiler waters. Certain of the downcomers would periodically either partially or completely clog and some of the more heavily worked wall tubes would burst at annoyingly frequent intervals.

After starting quebracho tannin feed the sludge problem in the first 400 psi boiler cleared up completely. In the case of the second 400 psi boiler, the slimy type of sludge disappeared also. However, in this unit a very thin, dark, brittle deposit now appeared uniformly throughout. There was also a heavy deposit around the downcomers back of the feedwater trough. This deposit had a magnesium oxide content of 35.5 per cent and showed a 62.8 per cent loss on ignition. The deposit in the downcomers continued to increase so that after some months several of these tubes became blocked with a deposit that consisted of calcium phosphate, magnesium phosphate, magnesium hydroxide and organic material.

More critical softener control was initiated at this time and sodium aluminate was added to the softener in order to improve magnesium removal. In addition a steel plate was tack-welded to the back of the feed trough to keep the feedwater from spilling over this side. At the next inspection the boiler in general looked clean except for seven rows of downcomer tubes near the center of the drum which were partially plugged. Since this looked like poor feedwater distribution, the plate at the back of the feedwater trough was more securely welded and an apron was placed on the front of the trough. These changes apparently overcame the problem with this boiler, and aside from a small amount of thin, flaky deposit, no further trouble was experienced.

Just about the time that conditions in the second 400 psi boiler seemed to be stabilized, a third 400 psi boiler was put into service. This was a 200,000 lb per hr 2-drum bent tube boiler with water cooled furnace. Considerable soft sludge rather uniformly distributed throughout the unit was noted at the first inspection, and within six weeks of going on the line, a tube failure occurred. At the next inspection three months later a thin, black, flaky deposit was noted on the first pass tubes and furnace wall tubes. This deposit apparently would build up and then slough off, as a similar flaky black deposit was found in the bottom header. Five months later a hopper tube failed, just one hour before the boiler was scheduled for a shutdown. Considerable black flaky deposit was noted in the headers, although the other hopper tubes appeared to be clean. Three months after this shutdown, another hopper tube burst. Little deposit was found in the ruptured tube and this consisted only of soft sludge. However, considerable sludge and flaky black material were found in the bottom drum.

Ten months later another hopper tube burst and, at this point, it was decided to cut out the tannin feed and institute a lower phosphate reserve with more precise control. Evidently this was the correct procedure to follow, and although some sludge was noted in the boiler after this, it was considerably decreased in amount over that previously noted, and the black deposit disappeared. Except for a very occasional tube loss, satis-

[1] Engineering service on boiler-water conditioning for each of the plants mentioned in this paper was supplied by Hall Laboratories, Inc. The organic materials employed were obtained from a number of different commercial sources; in some cases they were used on an experimental basis without the recommendation of Hall Laboratories, Inc.

[2] Other deposits showed up to 68% ignition losses.

factory conditions without dispersive have been maintained in all of these boilers for the past six years.

We have dwelt so fully upon this one plant history because it brings out a number of important points, among which the following may be mentioned.

1. Some boilers, such as the 200 psi units, get along satisfactorily with phosphate treatment alone.

2. In other units, such as the first 400 psi boiler, dispersive apparently appears to improve conditions. The evaluation of such benefit, however, is usually complicated by other changes as in the second 400 psi boiler.

3. Certain boilers, such as the third 400 psi boiler, just do not seem to tolerate organic dispersives.

4. Even very soft sludge may cause considerable trouble.

5. Any troubles may be alleviated or cleared up by the use of inorganic chemicals alone, perhaps along with suitable mechanical changes.

Quebracho tannin was the dispersive used in this case history and is undoubtedly less stable than some of the more recently introduced materials. However, this experience suggests that extreme conditions may arise in certain boilers under which any organic compound may produce harmful decomposition products.

Case History No. 2

This plant has 900 psi, 250,000 lb per hr 2-drum bent tube boilers with water cooled furnaces. Treatment of boiler make-up water consists of combination hot process lime-soda softening followed by phosphate softening. With this process, hardness of boiler make-up water is reduced to a value usually less than 2 ppm as calcium carbonate.

From the beginning, considerable sludge accumulation was noted in the first, second and third pass tubes. Analysis of this sludge showed that the major portion consisted of calcium phosphate and magnesium silicate, but small amounts of magnesium phosphate and magnesium hydroxide were also present. These latter two constituents are usually considered undesirable and have been found in many cases to produce a very adherent sludge. As a first step in improving sludge characteristics, the boiler water silicate was raised to 40 ppm in order to completely precipitate the magnesium as the silicate. Mechanical changes were also made in order to increase circulation.

At the next inspection, however, considerable accumulation of sludge was again found in the top portion of the downcomers. A decision was made by the plant engineers to make a trial run using a processed dispersive material. This treatment was instituted at a rate of approximately 5 ppm of the dispersive to the feedwater. At the same time alkalinities were raised considerably and the magnesium in the feedwater was further reduced.

An inspection after a 40-day run on the boiler showed definite improvement in the cleanliness of the drums and downcomers, although there were irregular patches of soft sludge noted in the lower part of the downcomers. The next run of seven months showed that deposits in the downcomers had definitely been arrested. However, some black-colored material had accumulated in the water wall tubes. This material was analyzed since the black material suggested dispersive breakdown to carbonaceous residue, but analysis showed only a normal ignition loss of 6 per cent by weight.

Analyses of black dusty material turbined from the lower rear water wall on more recent inspections have showed an ignition loss as high as 23 per cent, definitely indicating some breakdown of the organic material, but fortunately this has caused no difficulty. Subsequent inspections have revealed generally improved internal conditions. Thin dark-colored deposits have been noted in the drum internals and throughout the boiler, but, in general, these have been powdery and easily brushed off.

Case History No. 3

There are four 4-drum Stirling-type boilers in this plant. Two of these are 175 psi while the third and fourth are 500 psi. One of the 500 psi units has water walls. Make-up averages about 25 per cent. The chief problem was that the feed lines would become clogged with scale.

Using phosphate conditioning, usually with residuals on the high side, it was also found that considerable sludge would be present in the rear drums. Some sludge was also usually found in the downcomers from these drums. There was usually some oil present in the returns, but this was seldom found to an excessive extent in the deposits.

When tannin was fed continuously, the feed lines stayed clean. Also, sludge conditions in the rear drum and downcomers were considerably improved.

When a 500 psi, 100,000 lb per hr 2-drum bent tube boiler with water cooled furnace was installed in the plant, it was found that a thick coating of sludge was formed on the drums and rear header, which, fortunately, did not prove particularly troublesome. More serious, however, was a heavy deposit of fine, loose material which was sometimes noted in the water wall headers, while a small amount of black deposit was usually found in the bends of the top row of tubes into the top drum. Finally a failure occurred in one of the header connecting tubes, and a plug in the straight part between the bends was found to be present in this and the other similar tube on the other side of the boiler. This plug showed an ignition loss of 28.5 per cent, Fe_3O_4 of 13 per cent, while the remaining material consisted of normal sludge constituents. While no further tube ruptures occurred, thin but sticky sludge was found on the downcomers, and considerable black flaky material was found in the bottom headers and in the tubes connected to them. On account of the potential danger of this situation, the feed of tannin was discontinued. Another organic dispersive was fed at the rate of 3 ppm, however, in order to keep the feedwater lines and the rear drums of the Stirlings clean. During the next couple of years occasional tube losses resulted while rather recently several hopper tubes have failed in the 2-drum unit. All samples showed rather high ignition losses. For this reason the use of the dispersive has been discontinued. To prevent scale formation in the feed lines, slug feed of glassy phosphate through them has been started.

These latter two case histories show that more is involved in success or failure than the particular dispersive used — which was the same in both cases — and the pressure of the boiler. Other factors such as the type and completeness of softening undoubtedly also play a part. The whole boiler system is so complex that the exact conditions encountered in any particular boiler often cannot be predicted, and caution in the use of organic materials is usually advisable.

Miscellaneous Case Histories

A number of plants have reported elimination of economizer deposits by the use of modified lignin dispersives. Several of these, however, have had to discontinue their use due to the fact that blistering of the harder worked tubes would result. Presumably most of these plants were able to use the dispersive successfully because of more uniform heat transfer characteristics throughout, while in the few that reported difficulty, hot spots or excessive ratings evidently caused decomposition of the dispersive. One of the latter plants was able to avoid tube blistering and still get economizer protection by cutting the feed of dispersive from 10 down to 5 ppm.

In addition to the cases in which dispersive was fed in order to prevent economizer deposits, it is being used in a large number of cases for the prevention of feed line deposition. These boilers are mainly in the low pressure range, 150 to 250 psi, while a few run into considerably higher pressures. Raw water as well as softened water is used as make-up, although silica in feedwater is usually high.

Inspection of a 600 psi boiler after a short period of treatment with a modified lignin dispersive showed that while this treatment had minimized deposits in the steam drum and downcomer tubes, it had allowed deposition in the generator tubes which formerly were clear of sludge deposits. Apparently the dispersive in this case had merely served to delay deposition of the sludge.

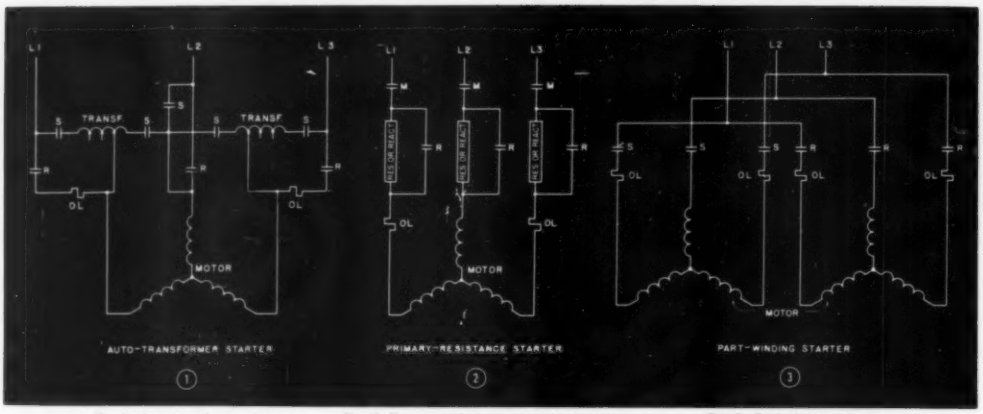

Fig. 1. Auto-transformer starter

Fig. 2. Primary resistance or reactance starter

Fig. 3. Part-winding starter

Decreasing the Starting Current in Induction Motors

Modern induction motors are usually designed to withstand the full line voltage during starting. The large peak of current resulting will not damage the motor. However, this current surge causes a voltage drop in the line which will affect the operation of other electrical equipment that may be running at the time. The longer it takes the motor to reach its running speed, the longer the voltage variation exists. A job being worked on by a machine tool may easily be spoiled by a sudden variation in the speed. For this reason, it is standard practice to supplement the motor with some type of starting device which will lower the voltage at the motor terminals until the motor has been brought up to sufficient speed

ON POWER SYSTEMS where there is no automatic voltage regulation the high starting currents of induction motors can cause considerable fluctuations in the line voltage. On systems where the voltage is regulated, provision should be made when starting a motor to increase the current in steps wide enough apart to permit the regulator to function properly. The systems discussed here are of the type which reduces the starting current directly; no consideration is given to those systems which are designed for "torque cushioning". The methods described here were condensed from a paper presented at the 15th Annual Machine Tool Electrification Forum, by H. L. Lindstrom, Engineer, Westinghouse Electric Corporation.

Auto-Transformer Starting

In the auto-transformer system of starting, an auto-transformer is connected to the line and the motor is connected to reduced voltage taps on the transformer. The simplest form of this starter is the manual type. The time of changing from *start* to *run* is left up to the discretion of the operator, which results in a disadvantage of the system. A loss of torque develops during the transfer period because one contactor must open before the other closes, to prevent shorting of the auto-transformer. Voltage taps, giving 80, 65 or 50 per cent of full line voltage result in 64, 43 or 25 per cent of full voltage torque. The selected percentage prevails during acceleration, giving a torque curve proportional to the original motor curve. The system results in a lower starting current than if no starting current limiting device were used. However, this is not the minimum possible current as the transformer is usually designed for a range of horsepower and not for one particular motor. A magnetic type starter may be used to replace hand operation in an auto-transformer starting system. This form lends itself readily to several possible variations including automatic acceleration by means of a time delay arrangement between the two steps and closed transition by use of additional contactors.

In the primary resistance or reactance type starter a resistor or reactor is connected in series with each phase. The starting current produces a voltage drop across the element, resulting in a decreased voltage at the motor terminals. When the motor is up to desired speed a time delay relay and a contactor act to short out the impedance, applying line voltage to the motor.

If a resistor is used, characteristics obtained will be higher power losses and greater line currents. The average resistor is designed to produce 70 to 85 per cent of line voltage during starting, depending on the motor design. If a reactor is used, the losses during starting are lower than with resistors. The reactor lends itself better to high voltage applications and the power factor during starting is lower than with resistors.

Part-Winding Starter

In a standard 220/440-v, dual-voltage, star-connected motor, nine leads are brought out. These can be

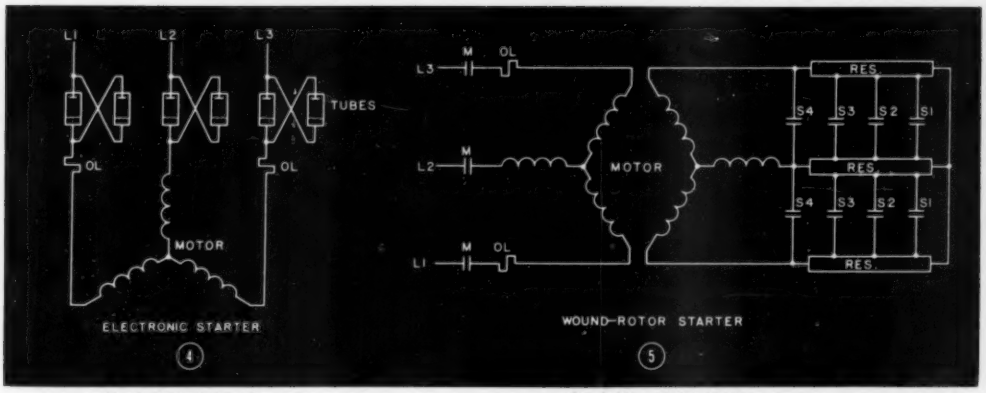

Fig. 4. Electronic starter

Fig. 5. Wound-rotor starter

connected into two independent 220 v star windings. If one of these is connected to the 220 v line it results in a current surge of about 60 per cent of the full winding surge, or about 50 per cent of the full winding torque. If the friction load and inertia are light enough the motor will accelerate to nearly full speed; and when the second winding is connected the current inrush is small. This means the initial surge is the maximum current. If the load prevents rotation or drags the acceleration out for more than a few seconds then the second winding must be connected after a time delay. This will produce a second large current peak and increase the torque to normal. Two conductors, each rated at half the normal horsepower and each with its own overload relay, are used for the two parts of the windings, together with a time relay.

A part-winding starter can be used on a dual voltage delta connected motor if one of the contactors is made full horsepower. This is not ordinarily suitable for connecting into two independent part windings; however, six leads can be brought out if requested on the order. Single voltage motors and motors for 440 and 550 volt service must be ordered special.

Electronic Starter

The electronic starter consists of electronic tubes or contactors, on which phase-shift control can be used to delay the tube firing time. This reduces the average voltage, current and torque.

Wound-Rotor Starter

The wound-rotor motor and starter shown here are both basically more expensive than the squirrel cage type. However, this system gives the maximum obtainable starting torque per ampere. The least expensive arrangement is a linestarter for the primary and a manual drum controller and resistor for the secondary. Magnetic types are available for pushbutton starting and modifications of this type can be used for a limited speed control.

A Cost Index

A cost index, with the manual type auto-transformer assigned a value of 100, has been set up including a totally enclosed, fan-cooled motor and each type of starter previously discussed. This index is an average of three motor sizes (25 hp, 100 hp, and 200 hp) for both 220 and 440 volts. Incidentally, it is interesting to note that the deviation from average is small for any one type of starter.

Table I. Tabulation of Starters

Type Motor	Type Starter	Cost Index, Motor plus Starter	Per Cent Full Voltage Values at Starting			No. Contactors	No. O. L. Relay	Auxiliary Equipment	Losses in Starting	Transition
			Terminal Voltage	Approx. Line Current	Torque lb/ft					
Squirrel Cage	Manual Auto-Transformer	100	50 65 80	30* 48* 71*	25 42 64	1-5P	2	Transformer	Low	Open
Squirrel Cage	Magnetic Auto-Transformer	121	50 65 80	30* 48* 71*	25 42 64	1-5P 1-3P	2	Transformer	Low	Open
Squirrel Cage	Magnetic Primary Resistance	119**	80	80	64	2-3P	2	Resistance	High	Closed
Squirrel Cage	Magnetic Primary Reactance	121	50 65 80	50 65 80	25 42 64	2-3P	2	Reactance	Medium	Closed
Squirrel Cage	Part Winding	105		60	50	2-3P	4		None	Closed
Squirrel Cage	Electronic									Closed
Wound Rotor	Drum Controller	193					2	Resistor	High	Closed
Wound Rotor	Magnetic Starter	220					2	Resistor	High	Closed

*Applies only to transformer designed for motor used.
**Same cost as auto-transformer above 40 hp, 440 v.

POWER for PALERMO

In the June issue we published an article discussing American technical aid in the construction of foreign power projects. Among other developments mentioned in that article was the Palermo power plant at Palermo, Sicily. This plant is of especial interest because it is built mostly of American equipment but its design involves distinctive European methods for achieving maximum strength with minimum use of materials

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THE Palermo Steam Power Plant of Societa Termo-Elettrica Siciliana, a public utility, supplies electricity to the City of Palermo, Sicily, for lighting and industrial use. This station is located in the City of Palermo, Sicily, adjacent to the Mediterranean Sea.

The initial installation consists of two (2) 30,000-kw turbo-generator units. The plant has been laid out on the unit system basis of single boiler feeding a single turbine installation. One similar unit of 30,000 kw will be added in the near future to bring the ultimate capacity of the station up to 90,000 kw. The first and second units are scheduled for initial operation in April, 1952, and August, 1952 respectively. The station is designed for pulverized coal fuel firing, the supply for which will be obtained from mines in Sardinia.

This project has received the financial assistance of the United States under the ECA Program, which was set up to give aid to the Marshall Plan countries.

Coal Handling System

The coal handling system is of the belt conveyor type capable of handling run-of-mine or crushed coal as unloaded from barges at the plant's docking area. This system consists of two sections as follows:

(a) A belt conveyor system capable of delivering 450 tons of coal per hr from three 5 cu yd capacity locomotive clam shell bracket type unloading cranes at the dock to a receiving hopper at the storage yard. The system consists of unloading cranes, receiving hoppers, conveyor belts, a belt type scale, a transfer tower and a main receiving hopper. The main receiving hopper is arranged to deliver the coal either to the Bradford type coal breaker or to the storage yard travelling and distributing conveyor. A drag scraper is also provided for spreading the coal over and reclaiming the coal from the storage area.

(b) The second belt conveyor system is capable of delivering 225 tons of coal per hr from the Bradford breaker to the coal bunkers in the boiler house. The system consists of an inclined bucket elevator, stationary belt conveyor, and a travelling tripper conveyor, above the coal bunkers.

Sufficient space has been provided for the future installation of equipment necessary for oil burning, should it become desirable to convert from pulverized coal to oil burning. Three future fuel oil storage tanks of 2,350,000 gal capacity each will be located north of the present coal storage area. The two present fuel oil barge unloading pumps of 1000 gpm capacity each will then be utilized to unload the oil from the barges to the future fuel oil storage tanks. (These unloading pumps at present pump oil to the two light oil storage tanks of 10,000 gal capacity each.) The future fuel oil storage tanks will be provided with suction type heaters for heating the oil up during the cold weather months. Two 60 gpm future fuel oil transfer pumps will pump the oil from the storage tanks to the future fuel oil pump and heater sets located in the boiler house. From here the oil will be pumped to the burners of the steam generating units.

Ash Handling System

The ash handling system for this station consists of two parts as follows:

(a) An hydraulic system for the removal by sluicing of pulverized coal ash from ash storage hoppers under each of the steam generating units to a concrete ash pit. Ash will be disposed from the ash sump pit by means of two 1500 gpm capacity ash pit pumps to a disposal area located approximately one mile from the plant site. The furnace ash hopper for each steam generating unit extends from the basement floor level to a point just under the pressure parts of the unit and completely encloses the furnace throat area. Each furnace hopper is arranged with a series of transverse curved feed plates formed by standard refractory shapes and separated from each other by crickets. At the upstream end of each feed plate is provided a deflector casting of heat resisting iron to protect the hopper wall from the impingement of water from the feed nozzle jet. At the downstream end of each plate a welded steel plate structure forming an integral part of the main hopper structure is provided as a housing for a counterpoised feed door, and the oscillating feed jet assembly. This assembly hydraulically moves and feeds the ash from the hopper feed plate

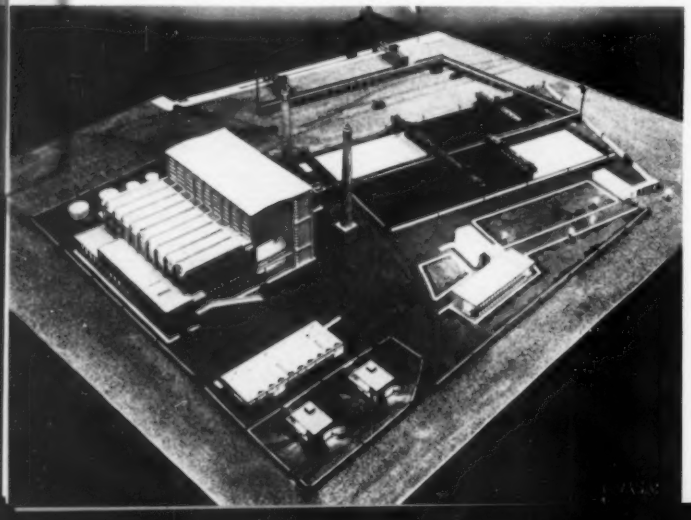


Fig. 1. Preliminary model of the high-pressure, high temperature steam power plant being constructed for the Societa Termo-Elettrica Siciliana at Palermo, Sicily

to the sluice system. At the upstream end of each feed plate, there are provided two auxiliary feed nozzles for assisting the front nozzle in removing the heavier ash from the feed plate to the sluice. A heavy cast iron sizing grid to prevent oversize material from entering the sluice system is provided inside the feed housing at each feed door. Sluice trenches are 18 in. wide and accommodate the liner plates, wear plates and nozzles. The trenches are designed to receive step-down type intermediate transport nozzles at all necessary locations. Cover plates and removable sections for trench inspection are tight fitting to prevent trench leakage. Two vertical ash sluice supply pumps are provided for ash sea water sluicing and the vacuum fly ash system.

(b) A vacuum system is provided for removing the fly ash from the fly ash hoppers of the air heaters, mechanical dust precipitators, electrical dust precipitators, and stacks through a system of piping to an hydraulic ejector, discharging the fly ash and water to the ash sluice trench from which it flows by gravity to the ash pump pit. From here the fly ash is similarly pumped to the disposal area.

Equipment sizes are based on the use of coals with a maximum ash content of 30 per cent, boiler hopper cleaning once per eight hour shift. Although two boilers are now being installed, design of ash handling equipment permits future total of three boilers.

The approximate quantity of refuse collected at each point in the system is as tabulated below:

	Per cent
Furnace Ash Hoppers	20
Air Heater Hoppers	5
Fly Ash Collector Hoppers	67
Stacks	8

The ash removal system including furnace ash hopper, sluice trench, sluice pumps and discharge piping is designed to handle ash at a rate of 40 tons per hr. The fly ash removal system is designed to remove accumulated fly ash at a rate of 12 tons per hr.

Control Rooms

An economic study revealed it more satisfactory to centralize only the boiler and turbine controls; therefore a separate electrical control room was provided.

(a) Boiler & Turbine Control Room — The boiler and turbine control room is located on the operating floor in the center of the heater bay, between the boiler and turbine rooms. The turbine panels and boiler panels are on the east and west sides of the control room respectively. They contain all the steam pressure gages, temperature recorders, draft gages, flow meters, tank level indicators, oxygen recorders, conductivity recorders, pH recorders, combustion control elements, pump control switches, annunciators, alarms, meters, and other instruments necessary to give the operators complete control of the boilers and turbines. The generator hydrogen control panels are located at one end of their respective turbine panel. The boiler and turbine panels are of the enclosed type provided with removable sections in the rear.

The lighting of the control room, though of high intensity, is so arranged as to avoid glare and shadows. To achieve this, a luminous ceiling of diffused glass panels has been utilized with fluorescent strip lamps mounted above the glass. Internal illumination is provided for all flow meters, recorders and draft gages.

(b) Electrical Control Room — The electrical control of the station is from a duplex control switchboard which is located in the electrical control room. This control room is located on a gallery above the electrical bay on the east side of the turbine hall. The front wall of the room consists of glass and steel partitions, thus giving the operator a complete view of the turbine hall.

This switchboard contains the controls for the generators, exciters, spare exciter, station service transformers, and the 10.5-kv feeders. All indicating instruments and control switches are mounted on the front panels and the relays and recording instruments are on the rear panels.

Control cables are located in open troughs below the switchboard and throughout the plant. Conduits are used only for individual isolated runs of control cable. All control cables are of the multi-conductor color coded type.

Intake and Discharge Tunnels

The 300-ft intake tunnel structure, consisting of two sections with a vertical concrete partition in the center, begins along the dock sea wall north of the coal barge unloading area. Water to the intake tunnel is obtained approximately 21-ft below the mean sea water level thereby providing an adequate year-round cool supply of condensing water for the plant. The intake tunnel bottom rises sharply about 11 ft, 6 in. at which point is located a series of bar screens (with removable shut-off gates) to eliminate trash from entering the tunnel. From this point the intake tunnel travels in a southwesterly direction, crossing beneath the port railroad facilities, and then turns south to parallel the east wall of the station. Before approaching the building, the intake structure widens and gradually deepens to permit installation of the four travelling water screens. Each screen is partitioned off with concrete walls and shut-off gates which are so arranged that maintenance work may be done on any screen without disrupting normal water flow in the tunnel to the building.

Prior to the widening of the intake structure, another set of shut-off gates is installed. These gates, in con-

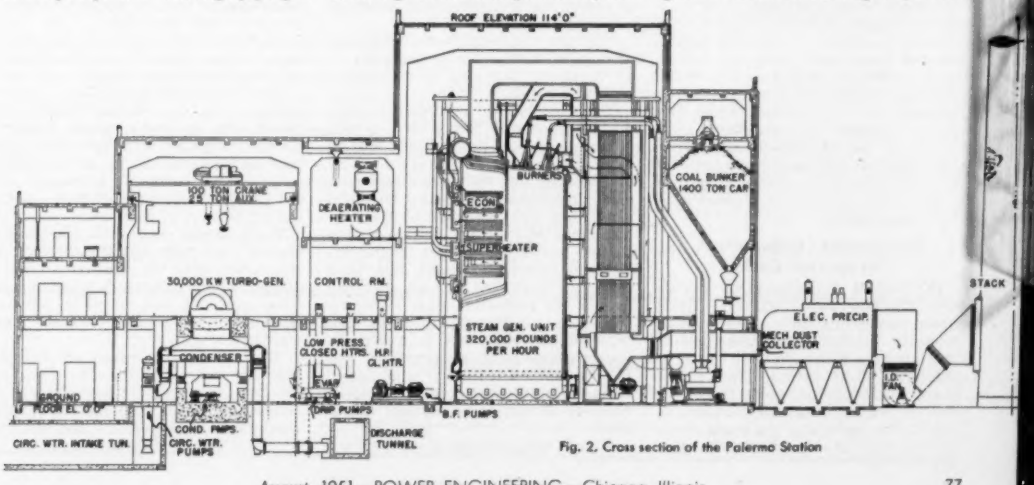


Fig. 2. Cross section of the Palermo Station

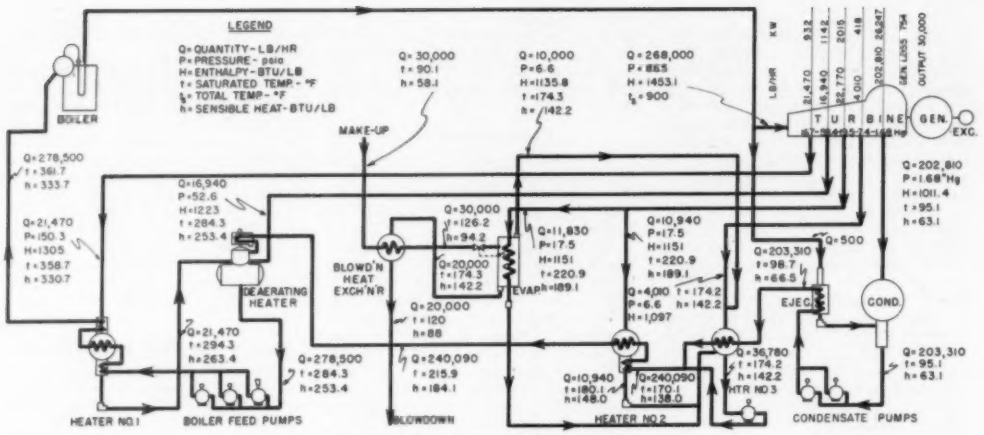


Fig. 3. Heat Balance Diagram for 30,000-kw Output

junction with those at the inlet of the intake structure, allow for shutting down either half of the intake structure between these points for cleaning.

From the outlet of the screens, the intake structure narrows and branches off to the west for each unit in the plant, entering beneath the Electrical Bay to the circulating water pump intake wells located in front of the condensers. The intake structure has been designed to keep turbulence down to a minimum. The entire intake structure from the inlet to the intake wells is of totally enclosed reinforced concrete construction and is beneath grade level.

The 1500-ft discharge tunnel structure is independent of the building structure and runs south, passing beneath pier railroad facilities, curving eastward, and discharging into the Mediterranean Sea at a point just past the second pier from the plant. In that the station is located along the Palermo Harbor, recirculation was avoided by obtaining water from one basin and discharging it into another basin. The discharge tunnel receives condenser circulating water, receives evaporator make-up pump sump overflows, and supplies water to the ash sluice pump sump. An adjustable weir is provided in the discharge tunnel for maintaining a siphon in the condenser circulating water lines at all times during operation. The entire discharge structure is of totally enclosed reinforced concrete construction.

Mechanical Equipment & Feedwater Cycle

(a) STEAM GENERATING UNITS AND ALLIED EQUIPMENT — Each steam generating unit is designed to generate 305,000 lb of steam per hr continuously with a 320,000 lb per hr maximum 2-hr rating. The superheater outlet operating conditions are 915 psi with a total temperature of 910 F. The boiler is of the single-drum radiant type having a horizontal continuous tube superheater which consists of two sections with spray type attemperator between sections for steam temperature control. The economizer is of the continuous tube type providing counter flow of water with respect to the flue gases passing over the outside tube surfaces in the top section and providing parallel water flow in the bottom section. Space is provided between the two economizer sections for the installation of mass action soot blowers. The temperature of the various sections of the furnace will be under automatic control to assure uniform temperature throughout the furnace.

The fully water-cooled furnace has a volume of 22,700 cu ft and yields a heat release of 17,400 btu per cu ft per hr when firing pulverized bituminous coal.

Each boiler is equipped with six burners located on the furnace top and firing downward. Three pulverizers are provided per boiler; however, with two pulverizers operating, the steam generating unit is capable of producing full maximum continuous rating.

Walkways and stairways have been arranged for complete accessibility to all necessary portions of the steam generating unit.

Each boiler is completely supported by supporting straps at the steam and water drum and is free to expand as a unit downward thereby eliminating elaborate seals and special construction necessary to allow for differential expansion of the various parts of the unit. Although the station has been designed for pulverized coal fuel, provision has been made for burning oil as an alternate should the necessity arise. Three retractable air-operated steam soot blowers per boiler are arranged for automatic sequential operation. The air heater for each boiler is equipped with four straight line steam soot blowers arranged for manual operation.

Steam temperature of each unit is automatically controlled by air operated equipment designed to regulate the flow of desuperheating water to the spray nozzle on the attemperator in accordance with air flow through the boiler, steam temperature leaving the attemperator outlet, and steam temperature leaving the secondary superheater.

An automatic air-operated combustion control system is provided. Coal firing is controlled in parallel with air supply, induced draft being readjusted in accordance with steam flow-air flow relationship. The pulverizer ratio controllers function to provide the proper air supply regardless of the number of mills in operation, through positioning of the primary air dampers. Fuel limiting relays are designed to cut down the supply of fuel in proportion to the supply of air available. Furnace draft is maintained substantially constant by positioning the forced draft fan vanes.

Coal flows from gunite-lined concrete bunkers of approximately 230 tons capacity each; a separate bunker supplies each pulverizer. The coal piping from the hopper to coal scale to pulverizer is short and straight to minimize stoppage of coal.

Each boiler is supplied with combustion air by a forced draft fan driven by constant speed motor. Volume regulation is obtained by inlet vanes operated by air-actuated controls. These fans are located on the ground floor in the aisle between the air heaters of each unit.

Each forced draft fan discharges the air vertically upward through a short duct into the tubular air preheater. The air heater is so arranged that one half can be shut off by dampers during maintenance and washing.

The combustion gases are drawn from the bottom of the air preheater through a horizontal duct which is connected to a combined outdoor mechanical dust collector and electri-

(*Continued on page 95*)

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

AN OLD READER RETIRES

Dear Sir:

I am sorry to have to inform you that age has caught up with me and that I retired from active service on May 1 of this year. I have been a subscriber to POWER ENGINEERING, back through *Power Generation* and *Power Plant Engineering* to the time when the magazine was called the *Practical Engineer*.[1]

I believe that it was around 1908 or 1910 when I first subscribed to the *Practical Engineer*, and I have been a constant reader of your clean, clear and helpful engineering magazine ever since. I have enjoyed it very much for nearly 40 odd years but now that I have retired, with great reluctance, I shall have to let my subscription expire.

Forty years is a long time if one thinks back but I do not feel that, at 65, I am very old. I have never had a real sick day in my life, for which I am very thankful.

During the years I subscribed to various other engineering magazines but dropped them by the wayside. I always did stick to what is now called POWER ENGINEERING and I can sincerely recommend POWER ENGINEERING to any real power plant engineer.

JOHN W. BRIGHAM
Nashua, N. H.

Editor's Note: We can appreciate Mr. Brigham's feelings about his retirement but realize that that time has to come to every man. After so long and honorable a service he can harbor a feeling of great satisfaction that he could contribute something to it during a very interesting and important period in the development of steam and electric power engineering. We wish Mr. Brigham many years of health, contentment and happiness. We cannot remember more than a half dozen men who subscribed to our magazine and read it over so long a period.

[1] The magazine was called the *Practical Engineer* until 1918. That year the name became *Power Plant Engineering*.

CONTENTS

Simultaneous Firing of Midwest Coal and Natural Gas .. 80

Which Wire is Which? 82
By L. W. Fitzpatrick

Venerable Engine, Running 95 Years, Still Going Strong 83

Keep Contaminated Condensate Out of Your Boilers 84

Know-how Saves V-Belt Money 85
By Paul C. Ziemke

Comparative Tests of Different Fuels 86
By C. T. Baker

Automatic Muller Control 88
By Howard T. Bailey

Don't Let This Happen in Your Plant 89

For the Plant Electrician 89
Capacitors Cut Costs at Shamrock Hotel
Largest Stranded Conductor
Suppression of Arcs Across Relay Contacts
New Method of Starting 3-phase Motors

Practical Hints and Kinks 91
Fly Ash Flows Freely in Insulated Hoppers
Belt Trouble Caused by Idler
Substitute Compass

Questions and Answers 92
He Wants to Know About Bearings
What's the Best Way to Determine Amount of Boiler Blowdown?
Will Mixing Sawdust with Coal in Bunker Increase Fire Danger?
Can Vertical Steam Engines Run Without Cylinder Lubrication?
What's Right Answer to Pipe Coil Condensation Problem?

A Section of Power Engineering Devoted to
PLANT OPERATION AND MAINTENANCE
Technical Publishing Company
110 South Dearborn Street, Chicago 3, Illinois

Simultaneous Firing of Midwest Coal and Natural Gas

In the February 1951 issue, G.B.K. asked for information on simultaneous firing of coal and gas fuels in industrial power plant boilers. He wants to fire these fuels simultaneously in the approximate ratio of 80 per cent natural gas to 20 per cent Midwest bituminous coal, the coal being burned on forced-draft-type chain-grate stokers (80 and 20 per cent refer to total Btu input). Many engineers may be able to get gas from new pipelines to burn in their existing coal-burning boilers. Here is some information on how this is done in two actual installations

THE ORIGINAL QUESTION stated that the installation consists of some 20-yr-old, 225-psi sectional header boilers fired with Midwestern coal on forced-draft-type chain grate stokers. Recently the air-cooled settings of these boilers were revamped to eliminate almost entirely the existing ignition arches. At the same time, provisions were made for future installation of gas burners through the rear walls. The idea seemed so simple and logical to the questioner that he assumed it must be quite common. A little investigation, however, convinced him — and us — that it isn't.

Everybody says "Why, that's no problem! Lots of people are burning coal and gas simultaneously. Look at the steel mills and the power utility plants." But when you look, you see that most of the steel mills burn coke breeze and gas. There are several industrial installations burning coal on multiple retort underfeed stokers, with gas fired simultaneously. The utilities burn pulverized coal and gas. Those are not the same situation G.B.K. has.

His survey and ours have turned up only a relatively few plants burning coal on chain grates and gas as he describes. Besides the two described below, there are one or two in Kansas, several in Iowa and one right here in Chicago, on which data will be presented later. Because of the possibility that engineers now firing bituminous coal on chain grate stokers may have gas available due to the extension of gas pipelines into their neighborhood, we have made a special effort to collect a little of this information, as given below.

First of all, in the case of existing installations, as a very approximate and tentative guide in checking up present furnaces, consult the data given in a paper on Furnace Design Methods With or Without Waterwalls, by Ollison Craig, presented before the Midwest Power Conference in 1948. However, it must be noted that Mr. Craig's data referring to traveling-grate-stoker-fired furnaces apply only to those equipped with front and rear arches. Consequently the change in the furnace design by the removal of the arches, described by G.B.K., may make some difference. In short, if adequate furnace volume does not already exist in coal-fired furnaces, the simultaneous firing method may not prove so successful.

According to Craig, for the coal burning chain grate stokers, ash fusion temperatures should be in the neighborhood of 1900 to 2200 F and the heat release in the furnace should be in the neighborhood of 30,000 to 35,000 Btu per cu ft of furnace volume per hour. For gas firing, the heat release in the furnace given by Craig is approximately the same amount. For a 50,000-lb-per-hr steam generating unit, says Craig, the furnace should be 10 ft 9 in. long. Distance from the center line of the gas burner to the tubes should be 12 ft 6 in. for a boiler of 50,000 lb per hr maximum continuous capacity.

With simultaneous firing, of course, the need for the ignition arches, which have now been removed, is not so great, although it may still exist to some degree. If the gas burners are installed in the rear wall, their flames will help to produce turbulence in the furnace gases. However, it is very difficult to generalize about this from the data given.

Recent Integral Furnace Boiler

However, here are some data on a recent installation of a Babcock & Wilcox Co. integral furnace boiler, Type FJ, designed for simultaneous firing of coal and gas and operating at a capacity of 42,000 lb per hr of steam on coal and 50,000 lb per hr on gas. The coal is fired on chain-grate stokers exactly as in the case of G.B.K. and the unit is designed for simultaneous firing of both fuels. Cross-sections, plan and dimensions of the unit are shown in Fig. 1.

Note that the gas burners are installed in what might be termed the end wall of the furnace and fire sideways across the direction of movement of the chain-grate stoker. Also, note that this is a different type of boiler from that described by G.B.K. Nevertheless, a check of the dimensions on Fig. 1 and the data given below indicates that they are not too far out of line with the data given by Ollison Craig. Following are details of fuel and air supply and location of the gas burners.

1. Each forced draft fan has been set up to meet the following requirements:
Net 58,000 lb per hr of air at 4.3 in.

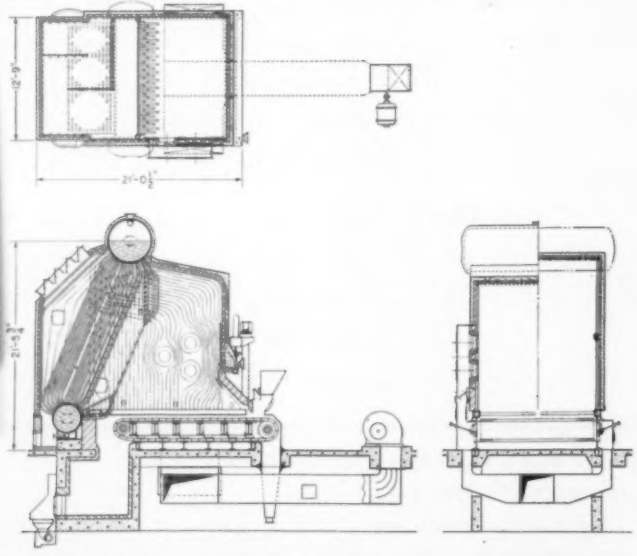


Fig. 1. Cross-sections and plan of 42,000-lb-per-hr integral furnace boiler, equipped for simultaneous firing by natural gas and Midwest bituminous coal burned on forced-draft chain-grate stoker.

H_2O and 80 F. Test block 72,000 lb per hr of air at 5.4 in. H_2O and 105 F

The motor driving the fan is rated at 20 hp at 1750 rpm

2. Bituminous coal of 1¼ in. size is burned, being obtained from Madison County, Ill., and having a heat content of 11,110 Btu per lb. The coal has the following analysis:

Proximate—% by Weight	
Moisture	13.57
Vol. Matter	37.55
Fixed Carbon	40.77
Ash	8.11
Total	100.00
Ultimate—% by Weight	
Ash	8.11
Sulphur	2.88
Hydrogen	4.32
Carbon	61.90
Moisture	13.57
Nitrogen	1.21
Oxygen	8.01
Total	100.00

3. The exact source of the natural gas is not specified but it will probably be obtained from gas fields in the Kansas City area. This gas has the following analysis:

Proximate—% by Volume	
Methane	84.10
Ethane	6.70
Carbon Dioxide	0.80
Nitrogen	8.40
Total	100.00
Ultimate—% by Weight	
Hydrogen	20.85
Carbon	64.84
Nitrogen	12.90
Oxygen	1.41
Total	100.00

Specific Gravity (Relative to Air) 0.630 Higher Heat Value

Btu per cu ft at 60 F and 30 in. Hg = 974

Btu per lb of fuel = 20,160

4. The lower burner is 4 ft 10½ in. above the top of the chain grate stoker and is 5 ft 3¾ in. from the front wall. The vertical distance between burners is 17 in. and the horizontal distance between burners is 2 ft 9 in. All dimensions are to center lines of burners.

5. Babcock & Wilcox register-type, 15½-in. forced-draft oil and gas burners are used.

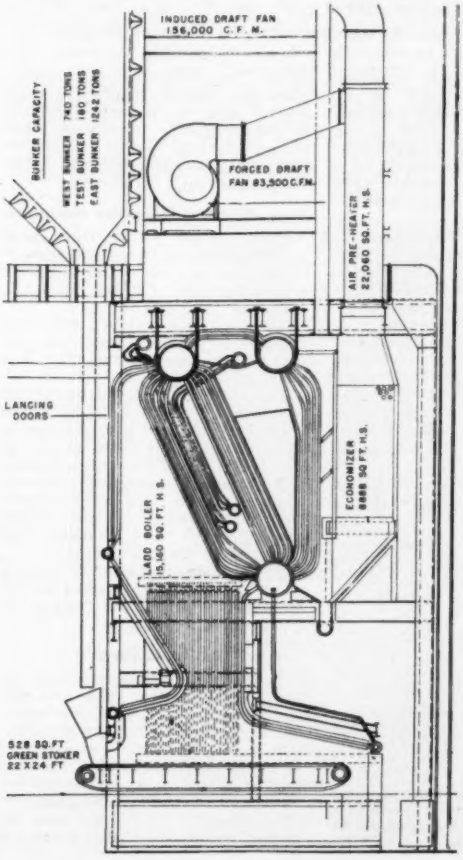

INDUCED DRAFT FAN
156,000 C. F. M.
BUNKER CAPACITY
WEST BUNKER 740 TONS
TEST BUNKER 160 TONS
EAST BUNKER 1242 TONS
FORCED DRAFT FAN 83,500 C.F.M.
AIR PRE-HEATER 22,060 SQ.FT. H.S.
LANCING DOORS
ECONOMIZER 6888 SQ FT. H.S.
LADD BOILER 15,460 SQ. FT H.S.
528 SQ.FT GREEN STOKER 22 X 24 FT

Fig. 2—Left. General arrangement of one of boilers at Grand Avenue Station, Kansas City Power & Light Co., equipped in 1941 for simultaneous firing of natural gas and coal

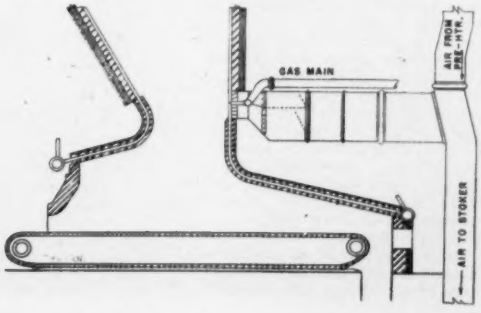


Fig. 3—Below. General gas burner arrangement on furnaces of Fig. 2 at Grand Avenue Station

This job started up without any trouble and data obtained so far indicate that the boilers are performing as expected.

Another Combination Job

Another installation that operated for some time under much the same conditions as those outlined by G.B.K. was described in much detail in a paper entitled Combined Firing of Coal and Natural Gas on Stoker Fired Units, by H. L. Crain, Plants Results Engineer, Kansas City Power & Light Co., *Transactions ASME*, April 1943, Vol. 65, No. 3, Page 137.

In 1937 gas burning equipment was installed under 3 boilers at the Grand Avenue Station of Kansas City Power & Light Co. These were Combustion Engineering Co. Ladd-type steam generating units of 225,000 lb per hr capacity each, of the 3-drum, vertical, bent-tube design. These boilers were designed to burn 1¼ in. Missouri coal screenings on forced-draft chain grate stokers of 528 sq ft area (24 ft by 22 ft) using preheated air at 350 F.

No trouble was experienced in burning the coal for which the boilers were designed but at times inferior grades of coal were received, particularly in winter. This caused coking trouble, poor ignition and other troubles, and resulted in lowered dependable boiler capacities, hence it was proposed to use gas purchased on a dump basis in connection with the coal to increase the dependable capacity and reduce rate of coal burning on the stokers.

Figure 2 shows a cross-section of the boilers on which this was done, while Fig. 3 shows the general gas burner arrangement first adopted.

Burner Installation

First installation of burner equipment consisted of four sets of 3 burners each, arranged in line across the rear boiler wall, approximately 11 ft above the stoker and just above the throat of the combustion chamber, Fig. 3. Burners were of the fish-tail type. There was no provision for pre-mixing of gas and air for combustion ahead of the burners; and air supply was through sets of stainless steel louvers surrounding each group of burners.

In operation, the burners and

louvers were pointed in such a direction that the temperature in the superheater zone was too high and, after numerous trial settings, the burner tips were finally rotated 180 deg to a downward direction, the air louvers being set to direct the air above the burners downward and that below the burners horizontally. This resulted in satisfactory furnace conditions.

Extension of this gas burning equipment to the two additional boilers was made in 1941, but these were somewhat different from the original. In one boiler 24 burners were arranged in two groups of 12 in 4 horizontal rows. In the other boiler the arrangement was with 20 burners in two groups of 10 with two rows of 5 each per group. All burners were of the fishtail type and the air supply was essentially the same as in the first installation. Gas of approximately 1040 Btu per cu ft at pressures from 10 to 15 psig was furnished.

Maximum gas consumption on any one stoker fired boiler was 256,000 cu ft per hr and maximum boiler rating obtained was 255,000 lb per hr. This represented 75 per cent of the total fuel requirements being supplied by gas and 25 per cent by coal. Average use of the gas on the stoker fired boilers was 25 to 30 per cent of the total fuel.

Operating Results

As reported by Crain, the combined firing of coal and gas was satisfactory in all respects in this plant. There was no change in average monthly efficiency over burning coal alone, no change in banking losses; and there was comparable base fuel cost. Fuel handling labor costs were reduced, maintenance on fuel handling and burning equipment was reduced and power consumption on fuel handling and burning equipment was reduced. There was, however, increased steam temperature and the paper discusses in detail the reason for this and the means taken to overcome it.

In discussion of the paper, E. R. Fish, Chief Engineer, Boiler Division the Hartford Steam Boiler Inspection and Insurance Co., called attention to a number of hazards in burning both gas and oil and pointed out that when combinations of fuel, such as discussed here, are attempted, the operating personnel will be "solid-fuel-minded" and relatively ignorant of the peculiarities of gaseous or liquid fuels. It is necessary, therefore, to pay particular attention to the additional training and instructions necessary to prevent accidents with this type of firing, he said.

Of course, since that paper was delivered, a great deal of attention has been given to this very subject and many of the precautions necessary and the safety devices recommended were described in the article Burning Gas in Modern Power Boilers by John H. D. Blanke, POWER ENGINEERING, March 1951.

Crain reported in his paper that from a load-handling standpoint the boiler with simultaneous coal and gas firing was very flexible and convenient. Dependable boiler capacities were increased and maximum capacities with existing draft equipment were increased 25,000 to 35,000 lb per hr per boiler. Use of gas, he said, helped ignition of poor quality coal and relieved coking trouble by reducing rate of coal burning and air temperature to the stoker. Lower air temperature resulted from cleaner steam and water heating surfaces. Use of gas had eliminated the necessity of using the air by-passes on the air preheaters. Another favorable item was the reduced time for bringing the boiler on the line in an emergency.

At the time this simultaneous firing was carried out at the Grand Avenue Station, the war was just beginning and the method had a good many advantages. However, by the time the paper was presented, towards the end of 1942, the war-time fuel conservation program was under way and the use of gas fuel was discontinued. However, it worked fine while it lasted.

Which Wire Is Which?

By L. W. FITZPATRICK
Chief Engineer, Department of Corrections
Jefferson City, Mo.

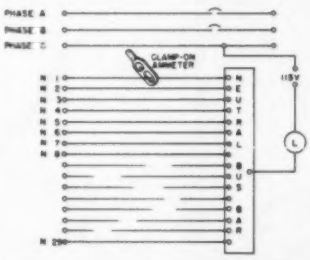
When re-wiring or modernizing circuits, you may often have trouble in finding the neutrals in 3-phase circuits. . . . Perhaps they were installed long ago and not marked in any way. . . . If so, here's a simple and inexpensive way one engineer worked out to identify them

THE OFT-DEBATED question "Which wire is which?" in re-wiring and new installation work has been settled once and for all in Missouri State Prison electrical systems through the development of a simple portable wire detector that gives the necessary coding without appreciable time effort.

It came about in this manner: During re-wiring for additional facilities in buildings, it was necessary to replace various circuits, make fuller use of existing feeders and interchange various motor feeders.

Naturally, two wires of the three-phase power supply could quickly be identified, for they were connected to a circuit breaker. However, when it came time to locate the neutral mate of the foregoing pair on the three-phase hookup, it was another matter.

The 440-v power panel had a total of 29 neutral wires all connected to a tie bar. They had been installed many years ago without identifying each neutral with its respective circuit. It was impossible to remove these wires one by one, because a portion of the circuits were energized and motor "single-phasing" would result.



Connected thus, the bulb will light, showing that current is flowing in one of the many neutral wires. Locating that particular lead is easy with a clamp-on ammeter

How We Identified the Neutrals

First, the 29 neutral wires were each checked and those that showed a reading on a clamp-on ammeter were eliminated, for we knew the circuits were in use.

The remaining fourteen wires did not show a reading, hence it followed that one of these was our stray. The following test set-up was made:

The neutral wire at the end of the service about 200 ft from the power panel was energized at its far terminus with a 500-watt 120-v lamp, as in Sketch 1. Then, 115 v was connected, current flowed through the wire in the bank in the duct and thence to the neutral strip on the circuit breaker panel. The ammeter was read and it showed 4.5 amp.

It was a simple matter to find the wire with a 4.5-amp reading on the remaining wires on the ground tie-point on the panel.

Using a Timer

Seeing the possibilities of this initial set-up for other cable and control wire determinations, the following set-up was made for portability:

A timer feeds 115 v, at a rate of 48 times per minute to a 300-watt heat element strip, which was selected because it is rugged, small and not easily broken. (A 300-watt lamp can also be used.) One lead is connected

to a 115-v power source on the "hot side." The wire in question is thus the neutral for the circuit.

The reason for the timer is that this relatively constant current interruption is easy to recognize and does not match anything encountered on a general power system nor on various equipment being turned on and off in the general vicinity of the testing operations.

In locating a wire in a duct or pullbox, the first wire of a two-wire circuit (the neutral) is located as explained before. Then, the "hot" wire is disconnected from the circuit breaker or fuse and purposely grounded. The same test is run on this wire and it is identified in the same manner through the swinging of the meter hand.

For a three-wire system, the same procedure applies: first, locate the neutral; then disconnect "hot" wires from circuit breaker and ground one at a time until located..

Any conventional clamp-on ammeter can be used for this test procedure and set on 0–10 amp, which will give a good needle deflection.

ALUMINUM PIPE LINES

NEW DEVELOPMENT in petroleum transportation is the use of aluminum pipe lines. The lightweight lines are said to be easier and less expensive to lay than steel. Lighter construction equipment can be used, the pipe does not require preliminary cleaning, does not have to be wrapped, and is much easier to weld than steel pipe. In operation, aluminum pipe is reported to have less internal friction than steel pipe.

Venerable Engine, Running 95 Years, Still Going Strong

IN OUR TRAVELS around the country we still find many steam engines in operation in industrial plants of various kinds. Many of these machines have been in more or less continuous operation for periods of anywhere between 25 and 50 years, a few even longer. Some are quite large. Until last year there was a large compound engine at the B. F. Nelson plant in Minneapolis, driving a paper machine through a great 6-ft wide belt. This engine has now been removed and the paper machine electrified. Gradually, the old war horses are being retired and steam turbines or diesels are taking their places.

At the plant of the Capitol Box Company in Sacramento, California, however, an old engine is still running, which, in point of age and years of service, probably tops all of the old timers still in operation. This engine was shipped to California, around Cape Horn, *one hundred years ago* and installed five years afterward as a second-hand piece of machinery. It is still going strong.

This engine, according to C. W. Palmer, Capitol Box Company's chief engineer, was the first such machine to be installed in California. Supplied from a boiler using wood shavings off multiple saws and planers as fuel, the engine develops somewhere between 350 and 400 horsepower though it was designed (?) for only 100 horsepower output. It has a 12-in. bore, a 29-in. stroke, and its overall length is some 20 ft. In 1906 a new boiler was put into use.

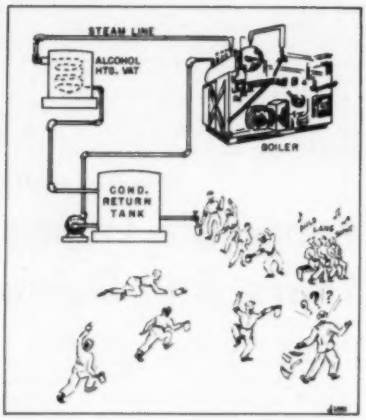
The factory has outgrown this venerable engine and new equipment is supplied with power from other sources, but it still drives two planers, seven saws and two re-saws.

Capitol Box has been maintained through the years by one family, the Towles. At the present time it produces vegetable boxes, egg crates and other kinds of containers. It has been at the same site, Second and Q Streets, since the spring of 1856 and the old engine has been running for 95 years.

EDITOR'S NOTE: For information and data on this old engine we are indebted to J. P. Elmore of the U. S. Bureau of Reclamation at Sacramento and to A. Calais of the same city.

This old slide-valve engine still operating at the Capitol Box Co. plant in Sacramento, Calif., was shipped around Cape Horn in 1851 at the height of the Gold Rush, and installed at the present site in 1856. It has been running for 95 years

Keep Contaminated Condensate Out of Your Boilers

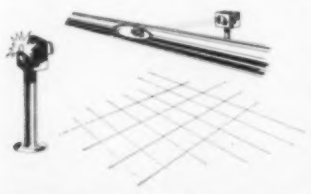


When boiler make-up water is obtained from condensed steam in the return lines there is always a risk of contaminants leaking into the lines and damaging the boilers. Sugar, tar, oil, acids and other foreign chemicals must be kept out of the boiler water. This article describes several methods to help the operator insure against serious boiler damage by preventing injurious substances building up to a dangerous concentration in the boilers

CONDENSED steam from return lines would seem to be an almost perfect source of boiler make-up water. But if boilers are fed with returns from any steam heated vessel containing material that would cause damage if mixed with the boiler water, a hazard is bound to exist. A large leak or break in a coil or jacket of such a vessel could cause enough pollution to damage the boiler before the break is detected. On the other hand, a "pinhole" leak can cause such a *slight* degree of contamination that it goes unnoticed or is considered insignificant; the foreign matter gradually accumulates in the boiler and may eventually reach a concentration sufficient to cause damage.

Apparently few industries escape trouble from contaminated condensate. Boilers in food processing plants, paper mills, power stations, chemical plants, textile mills and other industries suffer accidents caused by fouled returns. This was described by W. B. Parker, Asst. Chief Engineer, Boiler Division, the Hartford Steam Boiler Inspection and Insurance Company, in an article in that company's publication, *The Locomotive*.

In one university heating plant the operators assumed that the trace of oil in the returning condensate was a negligible amount. But with the small daily addition of oil, an accumulation gradually built up in the boilers because the oil did not exit with the steam. There was no indication of trouble until an operator noticed some badly warped tubes.



"When the beam is cut off, a warning signal sounds"

Typical Examples of Condensate Contamination

Fortunately he made this observation before any tubes had pulled out or ruptured. A similar condition occurred in a sugar refinery where a combination of oil and sugar leaked into the condensate. In still another plant, two damaged boilers were opened up and a heavy coating of tar was found. The source of the trouble was a broken steam coil in a tar heating vessel. The coil had broken completely in two, permitting large quantities of tar to flow back to the boilers with the returns.

Other cases of serious trouble, resulting from contamination of condensate by salt or acid are on record. One unusual case occurred when propane gas became mixed with boiler returns in a gas manufacturing plant. Leakage developed in a heat exchanger and permitted propane gas to pass into the steam coils and work back to the return tank with the condensate. A combustible mixture formed in the tank and exploded violently when touched off by a spark that probably originated in the return pump motor.

There are several more or less common ways to prevent contaminated condensate from reaching the boiler. The selection of one of these methods will depend to a large degree upon the size and type of the plant and the type of contamination that may be expected. In some cases it may be advisable to use more than one method. In other cases, methods not listed here may be more effective.

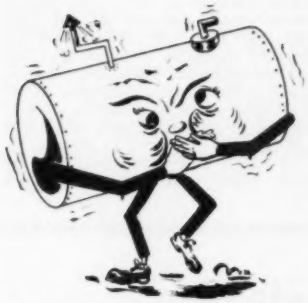
Obviously, the surest way to avoid trouble is to waste all returns that pass through any apparatus that could possibly cause contamination of the condensate. If the amount of such condensate is small, it would probably be more economical to waste it than to set up the equipment and procedures necessary for protection. If, however, it does not appear economically wise to waste the condensate, the cost of various means of protection should be weighed against the savings in heat, water and feed water treatment that are gained by using the returns.

Use of Heat Exchanger

A heat exchanger may be used to avoid wasting the heat in the condensate before the latter is discarded. With this system, the heat that is extracted from the returns is taken up by the feed water and sent back to the boilers. By this means, wastage is practically reduced to loss of water and treatment. There is some danger of contaminating the boiler water if a leak should develop in the heat exchanger, but vessels for this purpose are usually designed to withstand corrosion and other causes of leakage.

The Dual Return Tank System

A simple means of protecting boilers against fouled condensate is the use of twin return tanks. All condensate that may become contaminated is returned to the tanks which are arranged so that only one of them is connected to the boiler make-up line at any one time. While one tank is connected to the make-up line, the other is used to collect returns from the system, and when it becomes filled to a predetermined level, its contents are tested. If the test proves satisfactory, the tank is



". . . A combination of oil and sugar leaked into the condensate"

then switched to the boiler make-up line and the other tank is switched to receive the incoming condensate.

Measuring the pH Value

The preceding means of protection can be used regardless of the type of contamination. But the three methods that follow employ sensitive instruments that will detect only certain types of contaminants. They should be used only with the advice of feedwater specialists and according to the instructions of the instrument makers.

The pH measuring method can only be used where the type of contamination will show a positive acid or alkaline condition when mixed with the feed water. Meters for measuring the pH value of water are quite sensitive and can be employed in connection with a warning device that will signal the operator when the pH value of the returns shows a slight change.

The Photo-electric Cell Method

The photo-electric cell is quite effective in detecting fouled returns when the type of foreign material is such that a small amount of it mixed with the return water will cause discoloration or clouding. The photo-electric cell is focused through glass ports in the return line, and any discoloration or clouding of the water intercepts the light beam. When the beam is cut off, a warning signal is activated through a series of relays.

Conductivity Meters

Probably the most widely used protective device for detecting acids or certain chemicals in the returns is the conductivity meter. This device may be arranged to make a record of the electrical conductivity of the condensate, or it may merely be an indicator. Conductivity meters are generally used with a device which causes a warning bell to ring, or operates a dump valve which will send all condensate to waste if contamination shows up.

Combined Methods of Protection

Some plants devise methods of protection suitable to their own equipment, or combine various methods according to the degree of hazard involved. In one chemical plant, for example, the hazard was recognized after acid entered the boilers with the returns, but was fortunately discovered before any great amount of damage resulted. All acid heaters were changed to operate with a vacuum on the acid side and a positive pressure on the steam side. Thus, any leakage within the heater would result in a flow of steam or water into the acid instead of the acid flowing into and contaminating the condensate. The vessels were also equipped with protective devices which dumped all condensate to the sewer if the vacuum was lost. A small sampler tank was arranged to collect a portion of the returns for testing at regular intervals. A conductivity meter was installed and served to operate a dump valve if acid was detected in the water, and as a final measure of protection, a dual return tank system was installed.

Few plants require as much protection as this chemical plant, but the case demonstrates how important this question of contaminated condensate can become, and illustrates the need for carefully weighing the cost of protection against the hazards of inadequate protection in any plant.

Know-how Saves V-Belt Money

Here are a few sensible suggestions concerning the installation and care of V-belts that will not only save money but also much unnecessary grief from belts going haywire at critical times. Written by an engineer who has taken care of many such belts, the article is of particular value to practical operating engineers

By PAUL C. ZIEMKE

Oak Ridge, Tennessee

CONSIDERABLE confusion still prevails concerning the technicalities involved in the purchasing and use of the very versatile V-belt. One still hears all too often the statement from men who should know better — "I pull 'em all up snug when I replace 'em. That way there are no shirkers and each belt carries its full share of the load."

Yet very wrong that theory is; for, during a period in the development of a swanky new sub-division, before the new residents realized that their private well water was quite hard, and that fire insurance rates were prohibitive for lack of water mains, everyone had an electrically powered pump. A deluge of complaints to the several pump firms that the motors were prone to *pop* line fuses at the most embarrassing times led to a concerted investigation. All the installations were serviced by a country electrician and he didn't like squealing belts when the motor started, nor did he like slack that oscillated as the pump ran.

By the same token it is indeed foolhardy to attempt to economize by the replacing of only those belts in a drive that fail utterly. If one must be saving it would be a little less *Scotchy* if one retained the remaining members of a drive and carefully matched these with others to form a second rate set that might function with some degree of satisfaction.

Like the old saw — "How much wood could a wood chuck chuck, if a wood chuck could chuck wood?" a timely question is — HOW TIGHT SHOULD A V-BELT BE? Well, it should not necessarily be tight at all for a sagging belt is most assuredly no real cause for anxiety. Ask the manufacturer's representative; he knows. There is still too much confusion as to the relation between belt length and sag. With this befuddled thinking it is apparent that we have an exaggerated understanding of the difference in length between V-belts on a multiple belt drive.

The explanation lies in the fact that factory measurements of belts are made on conventional grooved pulleys spinning at rated speeds and

TENSION VALUES FOR CORRECTING BELT SAG

Sheave Center Distance-Inches	Sag in Inches						
	½	1	2	3	4	5	6
20	0.037	0.130	0.513	1.080			
30	0.037	0.095	0.343	0.780	1.51		
40	0.010	0.074	0.240	0.590	1.03	1.61	
50	0.008	0.028	0.200	0.440	0.83	1.27	1.86
75	0.004	0.018	0.170	0.300	0.60	0.87	1.25
100		0.025	0.054	0.120	0.40	0.66	0.94
200			0.030	0.060	0.21	0.37	0.42
300				0.035	0.16	0.29	0.35

under average load conditions. Hence the name *Matched Sets* is no misnomer at all. Each belt is legibly stamped with a number that will convey to the customer the plus or minus tolerance developed by the tension and measurement test.

The value 50 has been established by belt manufacturers as a base number. It then follows that any belts stamped with numbers below 50 are known as the minus tolerances while those above 50 are plus tolerances with a differential of 1/10 in. indicated. The same control decrees that the maximum length of difference allowed between shortest and longest belt in a matched set is only 1/10 in. per 100 inches, or 1/10 of 1 per cent. Obviously stretching the shortest belt of a given set this small amount will do it no harm whatever.

The table gives the differential in length between a belt which is tight and one which is loose on the same drive. The figures indicated refer to 180 degree contact of arc for both sheaves with some variation permitted for other ratios.

Believe it or not, some people actually LUBRICATE V-belts — just a little

There is considerable difference in the appearance of belts as they idle or carry full load with the most slack being present in the latter. This leads some engineers to believe that the belts "are wobbling all over the drive" and this obviously is a gross exaggeration engendered by ignorance of the underlying facts regarding sag and belt length. Note the table where on a center distance of 100 inches a sag of 2 inches would appear to be severe. Yet by adjusting the motor base just 0.054 in. wider as to sheave centers, the sag is removed.

A drive often tricky to engineer properly is one where, through modernization of the drive, only the driver is converted to a V-grooved sheave and the driven pulley is utilized *as is* with its crowned face that tends to keep the V-belts in place through their tendency to climb toward the center. Here is where the manufacturers' matching can really pay off since the longest members of the set will need to be placed on the crown of the driven pulley.

Any failure to comply with that precaution will all too soon wind up in an embarrassing tangle for the engineer, as the pulsating load tends to cause corresponding *fluttering* of the belt sag to a point where one belt member climbs over the other and the drive is practically ruined. Such a drive once carefully set up with matched belts will function well for years if the pulley faces are kept free of lubricants and the tension is carefully maintained. Obviously, of all belt drives this is one where old belt members cannot be run with new units.

Finally much condemnation of belt drives is unfounded since the

Comparative Tests of Different Fuels

By C. T. BAKER, Consulting Engineer

Table I. Comparison of cost factors in burning oil, coal, wood and slabs

	OIL	COAL	WOOD	SLABS
Number of tests considered	5	5	1	4
Cost of fuel (incl. frt.)	$1.19 per bbl	$4.86 per ton	$3.34 per cord	$2.475 per cord
Cost of unloading at plant (@ 4¢ per kw hr. (Oil)	$0.00671 per bbl	$0.1177 per ton	$0.085 per cord	$0.1765 per cord
Weight of fuel per unit of measurement (oil at 85 F.)	324 lbs per bbl	2000 lbs per ton	2752 lbs per cord	3500 lbs per cord
Cost per lb for fuel, incl. frt. and unloading	$0.005768 per lb	$0.002489 per lb	$0.001245 per lb	$0.0007576 per lb
Btu per lb fuel as fired	18732 Btu	13490 Btu	8962 Btu	7740 Btu
Cost of fuel per million Btu (incl. frt. & unloading)	$0.2011	$0.1845	$0.1389	$0.1095
Net equivalent evaporation from and at 212 F per lb (allowing 3.5% for burners in case of oil)	14.245 lb	9.452 lb	6.565 lb	4.0718 lb
Efficiency of boiler and furnace using given fuels	76.06%	67.67%	70.7%	51.0%
Cost of evaporating 1 lb water	$0.00026451	$0.00026331	$0.00018964	$0.00018606
Cost of evap. 1,000,000 lb water	$264.51	$263.31	$189.64	$186.06
Cost of evap. 235,000 lb water (Avg. 24-hr. evap.)	$62.12	$61.88	$44.57	$43.72
Cost per 24-hr handling fuel at plant (coal & wood passers)		$3.50	$3.50	$3.50
Net cost per 24-hr operation with given fuels (assuming all wood pd. for is received)	$62.12	$65.38	$48.07	$47.22
Percentage of wood pd. for actually recd. at plant			93%	100%
Net cost per 24 hr operation with given fuels, correcting for shortage in wood receipts	$62.12	$65.38	$51.43	$47.22

trouble experienced is all too often not the fault of the belts at all but is directly chargeable to the sheaves. Hard as they are, compared to the comparative softness of the textile and rubber belts, they do wear out in time to produce distorted grooves. There is also the mechanical abuse suffered as pulleys are *pulled* off the shaft or pressed on again. Much of that pulling or pressing is accomplished by nothing more technical than a heavy hammer in the hands of a husky mechanic. Next in importance is the frequent offense to good engineering where a careless job of alignment has been performed by the millwrights. Here the drive may have been right *once*, but the end play in motor shaft or the driver did increase slowly and the drive is now badly out of alignment to cause undue side wear and heating of the belts. Bent shafts, though rare, are mighty hard on belts too.

One might not expect to find this true, but some people actually *lubricate* belts just a little to avoid the screech as the motor is thrown across the line or to eliminate the squeak when running steadily. Better do a little tension adjusting and dress the glazed belts a little with sandpaper.

SOME YEARS AGO, while chief engineer of a group of utility plants, the writer had boiler tests made at one of the properties of the group, to determine the economic values of the different fuels available. Since cord wood and slabs, delivered to the plant site, were obtainable at a very satisfactory price, both were burned during periods of assured supply; but when wood fuels were not available in adequate quantity, oil was burned.

Cost of operation with the various fuels tested was not influenced by a variation in the cost of boiler room labor, because only one fireman was used on a shift, regardless of the fuel used. Both the cord wood and the slabs were trucked to the boiler room by plant laborers employed as general utility men. Most of the time, however, the suppliers delivered the fuel directly to the boiler room and adjacent storage area, convenient for handling by just one fireman.

The boiler plant consisted of two water tube boilers, rated at 200 hp each, and an open-type exhaust steam feedwater heater and a water treating system. Details of the boilers, such as tube heating surface, drum sizes and other physical dimensions, have been lost or misplaced, and unavailable for inclusion here. However, such data are not germane to the results of the tests reported here in the tables.

The pressure carried was 140 psig, with no superheat. One pound of pressure, or slightly above, was maintained on the feedwater heater which had been designed for a safe working pressure a few pounds above atmospheric pressure. This provided a temperature of about 210 F. All the heat absorbed by the water delivered to the heater was supplied by exhaust steam. The heater shell was protected against damage from overpressure by a spring-loaded safety valve, plus a back-pressure valve set to maintain a constant pressure on the unit.

In addition to the oil separator, which was an integral part of the heater, a second separator was installed on the exhaust inlet pipe to the heater.

The accompanying tabulations show the performance of each of the fuels tested. It will be noted that 3½ per cent of the steam generated was charged to the steam consumed by the oil burners for heating and atomizing the fuel oil. This was a very close value for the type of oil burners in common use at that time. The figure has been greatly improved since these tests were made.

Table II. Comparison of weights and Btu values of oil, coal, wood and slabs

	WOOD, LB	COAL, LB	OIL, LB	SLABS, LB
	BY ACTUAL TEST			
Wood, Lb	1	0.694	0.46	1.61
Coal, Lb	1.44	1	0.664	2.32
Oil, Lb	2.17	1.505	1	3.50
Slabs, Lb	0.622	0.432	0.286	1
	WOOD, CORDS	COAL, TONS	OIL, BBL	SLABS, CORDS
Wood, Cords	1	0.955	3.9	1.27
Coal, Tons	1.05	1	4.08	1.35
Oil, Bbl	0.256	0.245	1	0.325
Slabs, Cords	0.790	0.752	3.08	1
	BY ANALYSIS			
	WOOD, LB	COAL, LB	OIL, LB	SLABS, LB
Wood, Lb	1	0.652	0.477	1.16
Coal, Lb	1.53	1	0.734	1.78
Oil, Lb	2.10	1.36	1	2.42
Slabs, Lb	0.865	0.564	0.413	1
	WOOD, CORDS	COAL, TONS	OIL, BBL	SLABS, CORDS
Wood, Cords	1	0.896	4.04	0.91
Coal, Tons	1.11	1	4.50	1.012
Oil, Bbl	0.248	0.222	1	0.225
Slabs, Cords	1.10	0.987	4.45	1
	BY ANALYSIS			
	WOOD	COAL	OIL	SLABS
Btu per lb	8,962	13,724	18,732	7,740
Btu per unit of measure	24,600,000	27,450,000	6,100,000	27,100,000

Table III. Comparison of costs for equal economy of oil, coal, wood and slabs

	WOOD Local	WOOD By Freight	SLABS	COAL	OIL
Weight of fuel per unit of measurement (oil taken at 85 F.)	3432 lb per cord	2752 lb per cord	3500 lb per cord	2000 lb per ton	325 lb per bbl
Net equivalent evaporation per lb of fuel as fired (assuming 3.5% to be used by burners in case of oil)	6,648 lb	6.563 lb	4.0718 lb	9.452 lb	14.245 lb
Net equivalent evaporation per unit of measurement of fuel (assuming 3.5% to be used by burners in case of oil)	22822 lb	18057 lb	14250 lb	18904 lb	4630 lb
	Per cord	Per cord	Per cord	Per Ton	Per Barrel
TOTAL COSTS at which all fuels would be equally economical under actual operating conditions	$3.50	$2.77	$2.18	$2.90	$0.71
	4.00	3.16	2.50	3.31	0.81
	4.25	3.36	2.65	3.52	0.86
	4.50	3.56	2.81	3.75	0.91
	4.75	3.76	2.97	3.93	0.96
	5.00	3.96	3.12	4.14	1.01
	5.25	4.15	3.28	4.35	1.06
	5.50	4.35	3.43	4.56	1.12
	5.75	4.55	3.59	4.76	1.17
	6.00	4.75	3.75	4.97	1.22

Note: — A car of slabs as ordinarily loaded will average 8.5 cords of 3500 lb each. This weight of 3500 lb is applicable to comparatively green slabs — that is, to slabs which were sawed from green timber from 5 to 10 days previous to the time the weights were taken.

Automatic Muller Control

By HOWARD T. BAILEY
Supervisor Electrical Maintenance, Brillion Iron Works

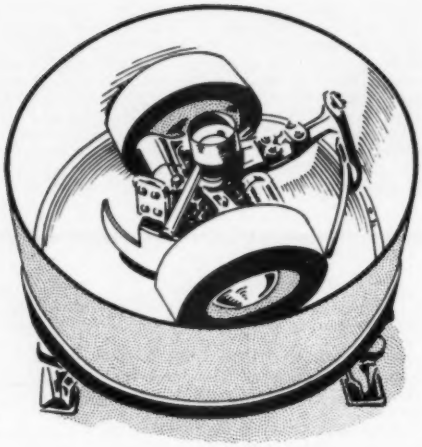


Fig. 1. Pan type mulling machine

KEEPING the proper mulling cycle is highly important in the preparation of facing for foundry molding operations. Mixtures that are mulled for too short a period do not make use of all the ingredients that go to make up the batch which invariably results in a poor mixture. Extended mulling cycles are also to be avoided as the tendency towards heating and a sticky mixture becomes more pronounced when the mulling cycle* is prolonged.

Obviously the person in charge of mulling operations cannot hope to obtain the desired results unless there is some kind of fixed time limit to control these cycles. In order to keep proper control of all the mulling operations the following provisions should be incorporated in the control:

1. The time cycle to be adjusted over a wide range to accommodate the different mixtures.
2. All batches to be automatically recorded at the completion of each cycle.
3. The blower to be started at the beginning of the cycle and shut off when the muller is being unloaded.
4. The possibility of dishonesty on the part of the operator to be eliminated by arranging the circuit so that the batches will not register if muller is unloaded before the time interval has expired.
5. Absolute accuracy is of prime importance as a control that could not be depended upon would be worthless to both operator and management.

With these thoughts in mind, an automatic control was designed by H. K. Leedy to control the operation of a 50-hp muller with all the above provisions included in its design. The control has been in daily use for the past five years and has proved satisfactory both in dependability and accuracy.

As will be noted in Fig. 2, Load Relay, LR, is energized through a current transformer that is connected in series with the motor leads. An increase in the motor load, corresponding to the setting on the load relay, will energize the load relay holding coil and will start timing operation in the control. At the end of the timing cycle the timer, through its associated relays, sounds the buzzer, warning the operator that the batch is ready to be unloaded; when the muller is unloaded the following operations take place:

1. Load relay drops out.
2. Timer is de-energized and returns to zero.
3. Count is registered on counter.
4. Blower solenoid valve shuts off.

Little maintenance should be necessary on a control of this type other than frequent inspecting and cleaning of relay contacts.

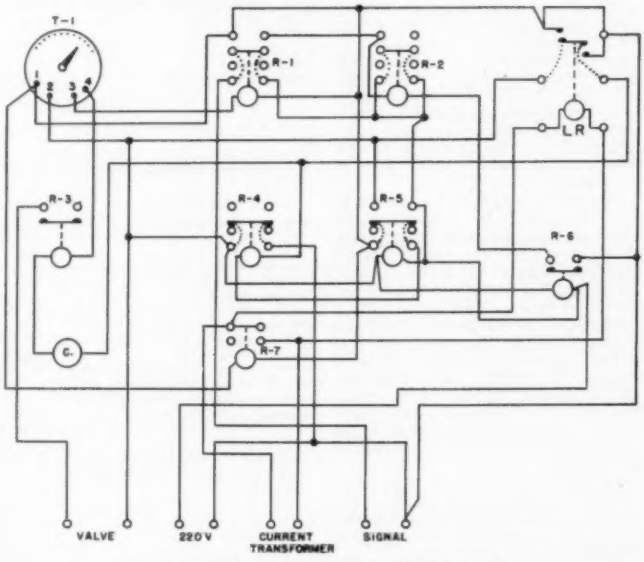


Fig. 2. Automatic control for the operation of a 50-hp muller

T-1: R. W. Cramer adjustable timer; one contact normally open, one contact normally closed. Magnetic engaging clutch. R-1, R-2, R-4, R-5: D.P.D.T. relays.
R-3, R-6: Single pole, normally open contact relays.
C: Counters
R-7: Single pole relay, normally closed contacts.
LR: Westinghouse load relay; adjustable for different load conditions. With this adjustment set for a particular load condition, counter will not register if load is too light.

* Mulling is a method of mixing solids with liquids. A mulling machine, also known as a pan mixer, putty chaser or edge runner is shown in Fig. 1. Muller wheels are disk like in form, revolving on their edges and creating pressure on the material by a constant rubbing action. Their action is similar to that of a mortar and pestle in that they knead and smear the material worked on, rather than grinding it.

Don't Let This Happen In Your Plant

TWO BOILER REPAIRMEN were rolling tubes in a water tube boiler. They were hot and wet as they worked in the upper drums because the valves in the header lines did not seal tightly, and a continuous flow of steam and hot condensate leaked into the boiler. On the second day the men finished the upper tube ends and went to work in the mud drum. But they had to leave the blowoff valves open to drain off the water that flowed down from the steam drum.

The work was nearly finished — only four more tubes to roll in the mud drum — when a fireman out on the operating floor noticed that the water level was too high in a boiler next to the one being repaired. He decided to blow it down, but forgot that men were at work in the adjacent boiler. The blowdown lines from both boilers lead to a common header, and when the fireman opened the valves a deluge of scalding water shot up into the drum and over the repairmen. The burns they received before they could escape proved fatal.

This tragedy should be a reminder to all who enter boilers. As reported in *The Locomotive* this and similar occurrences are not unusual cases. Many safety warnings have been issued on the subject, and the ASME *Suggested Rules For Care of Power Boilers* has this to say about it:

C-116 Before entering the shell or drum the plant inspector shall see that the blowoff and surface blowoff valve, the main and auxiliary steam valves, feedwater valves, and all other valves on connecting pipes are closed, and a reliable method of safeguarding these valves while anyone is inside the boiler shall be used.

It's simple and cheap to prevent such an accident. Attach a warning sign to valves that could admit steam or water to the boiler and you can be reasonably sure that no one will open the valves. A chain and padlock will guarantee that a valve will not be opened thoughtlessly. In one plant, the blowoff valve is taken right out of the line on a boiler that is drained for cleaning or repairs.

If your plant has special safety equipment for this hazard, use it — even if you are going into the boiler for "just one minute". It takes no more than a second or two for someone to open a valve and let scalding water or steam shoot into the open boiler. If special equipment is not provided in your plant, get it or make it; protection is so simple that there is no point in taking a chance.

FOR THE PLANT ELECTRICIAN

CAPACITORS CUT COSTS AT SHAMROCK HOTEL

THE MULTI-MILLION dollar Shamrock Hotel at Houston, Texas, has been able to cut operating costs by $760 a month by the application of capacitors to their distribution system, according to Glenn McCarthy, hotel president.

The hotel has 1100 rooms, some of which feature radio and television facilities and individual air-conditioning units. Prior to the installation of the capacitors, furnished by the General Electric Co., the huge hotel was maintaining only a 77 per cent power factor, and as a result had an average monthly power bill of $8940 for a six-month test period.

After application of a total of 1210-kvar capacitors of various sizes to their air-conditioning motors, motors driving their m-g sets, cooling tower motor circuits and power distribution feeder circuits, power factor was improved to 97 per cent. At this rate, the average monthly power bill, during the same six-month test period would be only $8180, a monthly saving of $760.

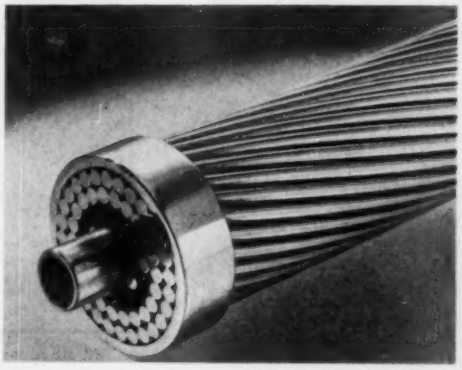
The total cost of all the material — wire, conduits, circuit breakers, capacitors, and the like, was only a little more than $9100, and at the present rate of saving, the installation should pay for itself in less than twelve months.

LARGEST STRANDED CONDUCTOR

THE LARGEST stranded electrical conductor ever supplied for an overhead transmission line is currently being manufactured by Aluminum Company of America at its plant in Massena, N. Y. The conductor, 1.6-inch diameter Expanded ACSR (Aluminum Cable Steel Reinforced), has been purchased by Appalachian Electric Power Company, a subsidiary of American Gas & Electric Company, for the initial part of a 315–330 KV transmission system. This system is described in "Technical Paper 51–11", presented before the American Institute of Electrical Engineers in January, 1951 by Philip Sporn, E. L. Peterson, I. W. Gross and H. P. St. Clair of American Gas & Electric Service Corporation.

Alcoa's introduction of this type of ACSR for super-voltage lines comes after twenty years of development and testing. In 1947, Alcoa supplied 1.65-in. and 2.0-in. diameter Expanded ACSR for the Tidd 500-kv Test Project sponsored by the American Gas & Electric Company.

Expanded ACSR is designed to provide the large diameter required to minimize corona, with economy in the use of metal, and at the same time to maintain the customary relationship between strength and loaded weight of conductor. The "Expanded" diameter of this concentric strand conductor is obtained by introducing nonmetallic strands of suitably treated fibrous



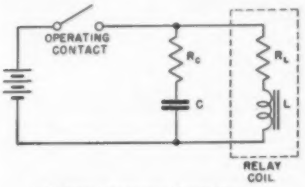
Showing construction of the 1.6-in. diameter electrical conductor for the initial section of a 315–330-v transmission line

material in the intermediate layers between the steel core and the outer layers of aluminum wires. The conductor is being shipped on 84-in. diameter steel reels, each containing 4500 ft of cable. The gross weight is 10,000 lb per reel.

SUPPRESSION OF ARCS ACROSS RELAY CONTACTS

ONE OF THE troubles encountered in the operation of inductive relay circuits, especially where the operation of the relay is frequent, is the burning of the operating contacts. To prevent arcing at these contacts, a series connected capacitor and resistor is usually connected across the relay coil. That such an arrangement damps the transient surge of the coil is well known, but the design theory is not as generally appreciated.

Some time ago, R. W. Gilbert gave a very clear and simple explanation of the theory of the surge suppressor circuit in *Weston Engineering Notes*, published by the Weston Electrical Instrument Co. This explanation may not satisfy the rigorous theorists but it is amply sufficient for the practical engineer interested in reducing maintenance costs.



R-C Relay Suppressor Circuit Diagram

The diagram represents a coil, having an inductance L and a resistance R_L, operated by a sensitive primary contact which is to be protected from current and potential surge transients. The coil is shunted by a series R-C circuit, consisting of a resistor R_c, having a value:

$$R_c = R_L = R \qquad (1)$$

and a capacitor C, having a value:

$$C = \frac{L}{R^2} \qquad (2)$$

Rearranging expression (2) gives:

$$RC = \frac{L}{R} = \text{time constant} \qquad (3)$$

so the time constants of the branches are equal. Also, from expression (2): the total resistance =

$$2R = 2\sqrt{\frac{L}{C}}, \qquad (4)$$

by resonant circuit theory and the circuit, L, C and 2R, is critically damped.

This combination of matched time constants and critical damping means that the impedances of the branches are numerically equal but of opposite reactive sign, therefore, the reactances cancel and the combined circuit is purely resistive at all frequencies. As a pure resistance the circuit cannot develop transients. The presented resistance is R.

The speed of response, however, is still limited by inductance, and can only be improved by increasing R_1 to reduce the time constant, which increases R_c and decreases C as design values.

In most cases *C* will be large and can best be a low-voltage electrolytic capacitor. But if the ideal is inconvenient, any R-C combination will improve the transient situation, provided the time constants of the branches are equal; neglect requirement (1) but observe:

$$R_c C = \frac{L}{R_L} \qquad (5)$$

as a concession design.

NEW METHOD OF STARTING 3-PHASE MOTORS

A NEW METHOD of normal voltage reduced current starting for induction motors was presented recently at the American Institute of Electrical Engineers Meeting, at Madison, Wisc. According to P. L. Alger, H. C. Ward, Jr. and F. H. Wright, authors of the paper, all of the General Electric Co., the scheme consists in connecting one phase of a three-phase winding in series during the starting period only, the other phases having circuits in parallel. When full speed is attained, the series connected winding is opened momentarily, and then put back on the line in parallel.

This gives the advantages of reduced current without any current surge on reclosing, no external impedance, and a low cost of control. It provides about half torque with two-thirds average current, as compared-to full voltage starting; it gives a smooth torque curve on the Y connection, and only a small one-third speed torque dip on delta connection; and it allows about 50 per cent greater stalled time than on full voltage.

Although this type of connection will draw unbalanced line currents, this appears unimportant. In most cases there will be other machines on the line to act as phase balancers and absorb the relatively small negative sequence current.

This split winding method of starting with K-2 (K equals the ratio of the number of turns in series of the

"We got to do some water conditioning. I never know what I'll find in it next!"

unbalanced phase to the number of turns in series on a normal balanced phase) gives fully comparable performance to the usual compensator method with an 80 to 85 per cent tap. It has the advantage of no current surge on transition from starting to running connection, of requiring less equipment, and an ultimately lower cost. The method may be applied to any dual voltage motor having 9 leads brought out. Single voltage motors especially built for this method will require only 5 leads brought out.

As compared to the part-winding method of starting, it has the important advantage of smooth starting on the first position, no current surge on transfer to running position, and adequate thermal capacity.

The split-winding method is especially adapted to cases where "soft" starting is desired, without any sudden torque peaks.

As compared to the reactor method of starting, the split-winding gives greater torque per ampere and requires less equipment and smaller size auxiliary contactors.

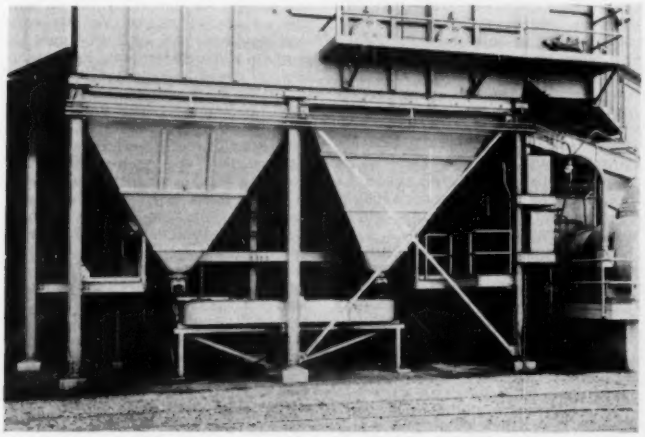
PRACTICAL HINTS AND KINKS

FLY ASH FLOWS FREELY IN INSULATED HOPPERS

MINERAL WOOL insulating blocks on outdoor precipitator hoppers at the Sewaren Generating Station of the Public Service Electric and Gas Company of New Jersey keep fly ash hot and dry — and flowing freely — in freezing weather. The hot fly ash from furnaces servicing Sewaren's boilers is stored in the hoppers and periodically emptied onto conveyors, dumped into trucks and sold (for fill, cinder block, etc.). Without insulation on the hoppers low outdoor temperatures would cool the fly ash, normally received at 284 F, and produce condensation of moisture. Wet fly ash is heavier, more difficult to handle than when dry and often sticks in the hopper; slowdown of the removal process and extra maintenance time are eliminated by the mineral wool jackets.

In the photograph, the two precipitator hoppers servicing the No. 1 boiler are covered with 1½-in.-thick mineral wool blocks in 12 x 18-in. sections. Externally applied, the insulating blocks were placed between lugs which were welded to the sheet-metal surfaces on 12-in. centers. To secure the insulation, galvanized iron wires were tightly stretched over the blocks and bound to the lugs. A layer of insulating cement, ¼-in. thick when dry, was trowelled over the blocks and was followed by a ¼-in. thickness of weatherproof finishing cement. Two coats of oil paint finished the installation.

The technique used to insulate the Sewaren hoppers is successfully applied in many industries where fly ash and other waste components are by-products of power generation. Carefully applied insulation permits uninterrupted operation independent of outside temperature.



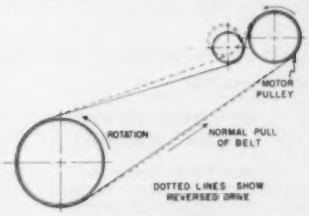
Fly ash hoppers at Sewaren Station insulated with mineral wool blocks. (Photo, Courtesy Industrial Mineral Wool Institute)

BELT TROUBLE CAUSED BY IDLER

By A. H. MOULTON

IN A PAPER MILL the belt on a 200-hp electric motor gave a lot of trouble by running off motor pulley and rubbing against motor frame, fraying the edge of belt. While there was no room for it to come off entirely, it rubbed so hard against motor frame that 4 inches were frayed off it in a short time.

This was an endless cord belt tensioned by a floating type idler which also acted as a belt guide and could be adjusted to hold belt in center of pulleys. And it did so as long as the motor was driving the shaft, but as the motor was tied in with a water wheel and a steam engine, and the



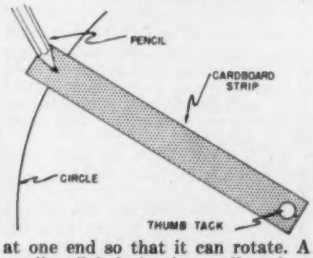
Sketch of belt and idler

water wheel was hand controlled from the beater room, when the room failed to cut off water when they dropped beater load, the water wheel or wheel and engine as the case might be took all load off motor, back-driving it and turning it into an induction generator. This would shift belt pull from bottom to top tending to lift idler, change its guide to throw belt off motor pulley, as it was not adjusted for this condition.

Various schemes were tried to prevent this, none of which worked. So it was decided to do away with idler, put on a 3-ply endless leather belt, tightened by sliding motor on base through tension screw. This cured the trouble. See sketch.

SUBSTITUTE COMPASS

A SIMPLE SUBSTITUTE for a compass for drawing circles is shown. This consists of a suitable strip of cardboard, held by a thumbtack or nail



at one end so that it can rotate. A small nail hole in the cardboard at the proper distance from the thumbtack permits a pencil point to draw the circle.

Questions and Answers

Q & A—THE POWER ENGINEER'S FORUM—

HERE'S HOW IT WORKS

YOUR QUESTION about some problem in operation, maintenance or design will be published, signed only with your initials.

Answers to your questions from other readers will be sent you as soon as received, then published as space permits, so that all may have the information.

You, too, answer questions from other engineers in the same way. You get paid well for published answers and also get the credit for knowing them.

If other engineers help you solve your problem, you express your thanks, via the Q & A editor.

Simple, isn't it? And effective! Just ask engineers who have tried it!

Answer No. 480

HE WANTS TO KNOW ABOUT BEARINGS

IN THE APRIL issue, A. C. asked about taking lead readings, also asked about: the various babbitt metals, the different kinds and what used for; should a bearing be poured on a mandrel; how and why are bearings grooved. Here's the practical experience of a man who ran bearing tests for a year for a large manufacturer of heavy equipment.

Pointers from McDermid

THE FIRST question relates to the so-called "lead" and "tin" babbitts. Scores of different mixtures have been tried, perhaps hundreds, but the usual formula is apt to run in the neighborhood of 80 per cent of the tin or lead, as the name indicates. As tin is the higher priced, it is natural that a "tin" babbitt costs more, but in certain services, it is incomparably the best. It will stand abuse and lack of care, especially poor lubrication, the best of any, without so much of a chance of failure. So, if your bearing is likely to be called upon to stand hard conditions, use a "high-tin" mixture, espcially if the bearing is small, if the item of first cost is not all-important, and if dependability is paramount.

"High-lead" babbitts can be just as well used, IF good care, and especially dependable lubrication, are provided, along with generous sizes of bearing areas. They will not stand up to high pressures as well as the tin mixtures, no matter how well cared for or lubricated.

Babbitt metal gets its name from its inventor, Sir Isaac Babbitt, who invented a "high tin" mixture, said to be some 200 years ago. His mixture was approximately 85 per cent tin, 10 per cent antimony, 5 per cent copper, later a trace of bismuth. The tin gave the mixture ductility and tenacity, the antimony hardness, the copper strength, while the bismuth gave it a high polish at the friction surfaces. It is safe to say that the original mixture is still very near unbeatable except in economy. High lead mixtures certainly beat it for first cost, but cannot beat it for all around dependability, especially if unfavorable conditions are encountered. As to the high lead mixtures, standard practice has settled on somewhere near 87 per cent lead, 12 per cent antimony, with 1 per cent bismuth. Some steel plant master mechanics swear by "antimonial lead" as they describe it, meaning a mixture of 85 per cent lead and 15 per cent antimony. With good care, especially as regards lubrication, some of the biggest mills maintain that it gives as good results as any. It must be borne in mind that the bearing areas must be of generous design for the pressures that are to be encountered, and the lubrication must be ample and continuous.

Pouring Babbitt

About placing the babbitt — one engine firm handling well over 100 tons of babbitt metal per month, used to pour in on smaller mandrels, and then bore out to size, as their standard regular practice. At one time they had on one order 25 gas engines, with main bearings 36 in. by 48 in. — a total of fifty main bearings — 100 half shells. These were poured rough in the shop, erected on the job and a boring bar set up on the final location, which machined the bearings for these 40-ft long shafts right in position.

So, if one has large important bearings with which to deal, he can have an excellent example to follow, especially as most of the heavy machinery firms follow the same system. This is the type of machinery found in large mills, which same are sure the bearings are satisfactory when made of "high lead."

The firm above noted used a mixture on that job, and as their standard, for 1200 tons per year, of about 63 per cent tin, 22 per cent lead, the remainder antimony with a trace of bismuth. They manufactured their own babbitt and kept this work under the control of an expert practical metallurgist and a high-grade chemical laboratory. To further aid them in dealing with babbitt problems, they designed and built a testing machine in their physical testing laboratory for the making of practical running tests on samples of all the kinds of babbitt metals that seemed possibly useful.

First, a babbitt sample was chemically analyzed to determine just what was in the mixture. Then a sample for mechanical running test was made up, being poured in the test block and bored to exact size. This test block was placed on a smoothly ground test journal, set in the center of a shaft, which was supported on two service bearings. The test block was held from rotating with the shaft by rigid stops, and was arranged so that with a system of compound levers, any pressure from 50 psi to 2000 psi projected area of the test block could be obtained, with every precaution taken to prevent any misleading pressures such as any manner of side twists, entering into the results. Then the bearing, having been machine fitted to the newly groundjournal (it was reground for each sample tested) as closely as possible, was then spot scraped to as perfect a fit as could be made.

Then it was placed in the machine and "run in" under oil bath lubrication, with careful load control and close watching of its temperature, which was never allowed to rise to any great extent, until the test bearing showed a smooth cool-running glazed surface over 85 per cent of its projected area. The entire machine was allowed to cool down over night to be sure it reached room temperature, the oil bath removed, and an accurately feeding oilcup set up to feed 60 drops per minute into the oil grooves of the bearing. Next the test piece was loaded at 200 psi and run under five minute temperature readings until the load produced its maximum steady temperature — then the load was increased to 300 psi and its behavior recorded — and so on until the bearing under steady lubrication and speed failed by fusion. The company ran these tests steadily for two years, the last year under the handling of this writer — each "run in" took from 40 to 50 hr and each final test from 8 to 16 hr, the finals running continuously until failure of the test piece.

The summary of the two years exhaustive tests showed that the "high lead" blocks always failed on this test with constant speed and lubrication, at 500 to 600 psi load. Not one ever carried the 600-lb load successfully — the "high-tin" samples always carried 1200 lb and one especially good one went to 1600 lb and then the side bearings of the machine failed before the test block did. In general, we proved that the life of a

babbitt bearing is a function of real lubrication largely — that to lubricate properly, the oil must get *between* the surfaces — not just somewhere near them — that oil grooves must be "relieved" on the "entering" edge, so the oil will be drawn in between the rubbing surfaces without any chance of its failing to really get where needed.

Most bearing designers allow plenty of area for the loads carried, and the majority of failures of babbitt bearings mean that some way the lubrication failed to get between the rubbing surfaces. That situation could come about through plain neglect of oiling — by leaving the "entering" edge of an oil groove to bear hard against the journal, so instead of the groove feeding oil to the surfaces of the unrelieved edge it is actually scraping the oil off and away from the rubbing surfaces, instead of helping it to its proper place.

Like the old woodworker's answer to question "How often should your machine's knives be ground?" his reply was, "Every time they get dull" — so, oil grooves should be so placed that they will carry oil to all the rubbing surfaces, being also careful that excess and unnecessary grooves are not used, for they will only cut away good rubbing surface that could better be used to support the load carried.

Care should be taken not to overheat babbitt when pouring, as much of its value can be easily burned out of it and the surface is likely to become and stay gritty, instead of polishing down to a smooth and nearly frictionless surface.

Journal as Mandrel

On some jobs, where slow speeds and easy conditions are to be encountered babbitt can sometimes be poured directly in place using the journal for a mandrel. If the heat is not great enough to permanently deform the shaft, the job may get done with no worse penalty than lots of scraping — always a slow expensive job — to counteract the shrinkage which will make the fit too tight unless so fitted after pouring. On high-speed light shafts, such as often are encountered in woodworking machines, it is first class practice to make a mandrel around 0.003 in. per inch of diameter larger than the shaft that is to run in the bearings; pour your bearings on that. The shaft then can be placed in the bearings true and perfect and the two fitted together with very little scraping, resulting in a very nicely running job, that you can go away from soon and forget all about.

Handling a Hot Bearing

Here's another good stunt if you are plagued by a hot babbitt bearing. Let it run as hot as you dare with plenty of lubrication, but stop it before surface damage is done to either the journal or the babbitt. Then let it cool down stone cold, and re-start it. Most always it will then run as cool and sweet as you please.

The explanation is that the hot shaft has expanded faster than the babbitt has and has forced the "high spots" of the babbitt back out of heavy contact with the journal, so that when the system cools down, there is tiny clearance where the hot spots used to be, though the fit is still snug, and really better fitted than any mechanic can do it. The net result is that you get a better job with vastly less work, IF you know how to use judgment.

Cincinnati, Ohio H. B. McDERMID

Answer No. 483

WHAT'S THE BEST WAY TO DETERMINE AMOUNT OF BOILER BLOWDOWN

IN THE May issue, S.E.R. asked for comments from Q & A readers on the various ways of determining amount of boiler blowdown. The ways he mentioned are: hydrometer, evaporation and weighing of solids, chloride test and conductance measurements.

TDS Means Little All by Itself, says Brage

THIS QUESTION intrigues me, so here is what I think on the matter:

There are many very good and scientific ways to find the right amount of boiler blowdown. For example, P & MO alkalinity tests are usually regarded as just the thing, with conductance measurements (electrical), hydrometer tests and weighing the solids obtained by evaporating a measured quantity of water.

Personally, I am of the opinion that the TDS is relatively unimportant. Rather it is the chemical constituency of the total dissolved solids that counts. Zeolite softening of water processes, for example, always increases the TDS over and above that of the raw water.

This boils down to the point (actually and figuratively) that one solid precipitates a scale or sludge at a given concentration, while another solid precipitates a scale or sludge at a higher or lower concentration. Temperature and pressure, and the steaming rate, also are important factors to consider in boiler blowdown, as both are instrumental in the process of precipitating dissolved solids.

There is no "best method" of finding the TDS. Also, the TDS, when found, means little without a knowledge of the chemical constituents of such solids as they existed in the boiler under the pressure, temperature, and other conditions prevailing there.

Spokane, Wash. OLIN LEE BRAGE

They Have Used 3 Methods, says Penokie

WE HAVE used three methods for determining blowdown of our boiler water, and over a period of two years have found that satisfactory results could be obtained by the chloride test, conductivity test, or by gravimetric analysis. However in cases where sludge is appreciable, the total solids may be the best indication of required blowdown. The gravimetric analysis is the most accurate way to determine total solids but it is too slow in most cases.

The conductivity test is not a direct measure of total solids, because the sludge particles have no effect on the test; only the dissolved solids affect the meter. However, the ratio of sludge to dissolved solids can be determined and this ratio can be used to calculate the total solids from conductivity readings in micromhos.

The ratio may be found as follows: Collect several samples of boiler water and determine their conductivities, then find the total solids gravimetrically as follows — Put 50ml of boiler water in a weighed evaporating dish and slowly evaporate to dryness; reweigh. Ppm total solids = weight of residue in grams $\times$ 20,000. Divide ppm total solids by conductivity in micromhos to obtain a factor to find the total solids directly from the conductivity reading. Factor $\times$ micromhos = total solids.

Average the factors obtained from several samples taken over the normal operating range of the boiler and obtain an average figure. Check it from time to time especially if there is a change in water treatment.

Calumet, Mich. CHARLES PENOKIE

Answer No. 484

WILL MIXING SAWDUST WITH COAL IN BUNKER INCREASE FIRE DANGER?

THEY MIX about ½ car per week of pattern shop sawdust and shavings with the coal in their 400-ton concrete bunker, said C. E. B., May issue. It improves the handling qualities of the coal and offers no firing problem in the stokers.

But C. E. B. wants to know if it increases or decreases the dangers of spontaneous combustion in the bunker.

Ambitious Al, in June issue, said don't worry about it but provide CO_2 pipes into the bunker, or use dry ice, as Consolidated Edison Co. does to put out any bunker fire that may start. Here is more.

Must Be High Ratio of Sawdust to Coal, says Brage

HERE IN the Northwest, where there are more sawdust piles than there are cows in Texas, no forest fire that I ever heard of has been laid to spontaneous combustion in ary a one of them. They will soak up rainwater, and fresh sawdust will heat, just like grain in a bin. But to catch fire and go to blazing is something else again.

As every old-time ice cutter knows, sawdust tends to stop air circulation and thereby prevent meltage of ice

in storage. However, it will not inhibit spontaneous combustion of coal unless it is mixed in large proportion with the coal. In other words, there must be a high ratio of the sawdust to coal.

Spokane, Wash. OLIN LEE BRAGE

Theoretically, Yes; Practically — Quien Sabe?

THE QUESTION concerning mixing sawdust with coal increasing the fire danger in a bunker can only be answered by considering the nature of heat of combustion as it applies to spontaneous combustion and particularly the case in point.

Combustion is not restricted to open flames but is everywhere. Iron rusts, wood rots, human body tissues perspire, all being in an act of combustion as oxygen combines with chemical substances releasing heat energy. The heat quantity is known as the "heat of combustion."

Coal is *always* in the act of spontaneous combustion. The reason that it is stored without burning is because the heat of combustion has been minimized by depriving the coal of necessary excess oxygen thus lowering its temperature below that temperature at which combustion could take place.

General factors for spontaneous combustion of fuel are: size; moisture; oxygen supply; temperature; ventilation; and conductivity.

Moisture is a catalyst in the oxidation reaction and the addition of wood waste and sawdust with its high moisture content would hasten combustion.

In coal bunkers as a rule, gas pockets in fuel, which cause spontaneous combustion, cannot form because the coal is generally kept moving slightly at all times when discharged into the plant.

High flash-point mineral oil is sometimes sprayed on coal to prevent spontaneous combustion. When saturated, the coal cannot absorb moisture or oxygen until its temperature and surroundings reach the general flash point of the particular oil, which is from 125 to 180 F.

From the foregoing considerations, technically the addition of sawdust or any waste wood substance would increase the fire danger of coal in a bunker. However, whether or not this would be the "straw that broke the camel's back," cannot be answered by anything other than actual experiment.

Fire insurance requirements often demand that a collecting method be installed in plants and all refuse pulverized and collected in a storage bin, which is further connected to supply the boilers. Waste fuel is then automatically fired according to the boiler operator's wishes.

The same general conditions also apply to the storage of sawdust and other wood wastes in a bin as regards spontaneous combustion.

L. W. FITZPATRICK

Jefferson City, Mo.

Answer No. 485

CAN VERTICAL STEAM ENGINES RUN WITHOUT CYLINDER LUBRICATION?

AMBITIOUS AL brought up this old one in the May issue because he heard it discussed by old-time steam engine men. Some of them told him it could be done, but couldn't show him an example and all the engines he'd ever seen were lubricated.

However, in the July issue he was assured by several engineers that they had operated such engines and that it can be done under proper conditions.

Principal of these is that they shall use very low-superheated steam and preferably saturated steam. Another condition sometimes mentioned is that with saturated steam, the cylinder condensation will do it — BUT — if you once start lubricating the cylinder with oil, you must continue it and can never go back.

Another theory we have heard is that the graphite in the cylinder iron works to the surface and, together with the moisture, forms a lubricant.

Most important, however, is the fact that the minute you get engines using high-temperature steam and especially designed for that, you've got to use real lubrication in the cylinder.

What the Navy Used to Say About It

MY OWN EXPERIENCE has been only with turbine and Diesel generator units, but Ambitious Al may be interested in what the old Navy Manual of Engineering Instructions had to say on the subject of lubrication of steam cylinders on reciprocating engines.

"7-674 (1) Care shall be taken that the oil used for lubricating the piston rods and valve stems is not applied more freely than is necessary to prevent heating; and precautions shall be taken to prevent an excess of oil being drawn into the cylinders and valve chests and then passing to the boilers . . .

"(3) . . . care shall be taken to prevent the oil being splashed on piston rods and valve stems particularly from crossheads and guides. Wipers on piston rods and valve stems will help keep oil from being drawn into the cylinders and valve chests.

"7-675. No graphite, tallow, or oil of animal or vegetable origin shall be used for the lubrication of piston rods, valve stems or the interior lubrication of steam cylinders and valve chests and as little as possible of any kind of oil shall be used for this purpose. (This instruction shall apply to every steam cylinder and valve chest for whatever purpose used.) Under ordinary conditions of working with saturated steam or superheated steam up to 75 deg of superheat at the engine, the water of liquefaction derived from the steam, and the oil carried in on the rod or stem should furnish ample lubrication for the working parts, but if this does not prove sufficient, pure mineral cylinder oil only shall be used."

That's as close as I know to non-lubricated steam engines. It would appear that low superheat in the steam is the key requirement.

R. H. FREYBERG

Pleasantville, New York

Answer No. 486

WHAT'S RIGHT ANSWER TO PIPE COIL CONDENSATION PROBLEM?

SOME MONTHS ago, Q & A readers were asked for the rate of condensation per square foot of a 1-in. pipe coil carrying 135-psig steam and submerged in 60-F water. Several replies all gave different answers, such as: 0.12, 0.9335, 126.7, 171.6 lb per hr.

In the June issue we asked Q & A readers to set us straight on this. Here's what Ira Butcher has to say.

Many Variables Affect It, says Butcher

ANSWERS to this question certainly are grounds for thinking engineers are a bunch of squirrels. However, they still get things done despite their apparent battiness. If it is important to know how much steam will be condensed under the conditions stated, why not try it out?

Many variables will affect the rate of condensation; some of them are as follows:

Is the pipe to be installed in a horizontal or vertical position?

Is the water quiet or does it flow and if so how rapidly over the surface of the pipe?

Is the pipe a dead end condenser or does the steam flow rapidly through it?

Is the pipe standard, extra strong or double extra strong? Wall thickness effects the heat transfer rate.

Of what material is the pipe made? Aluminum, brass, carbon steel and stainless steel are all common pipe materials and vary greatly in their heat transmission capacities.

Tank coils are commonly said to have a heat transfer rate of 225 to 475 Btu per sq ft per hr per deg F temperature difference, while the same author says a reasonable practical heat transfer rate for high pressure tank coils with natural circulation is about 200 Btu per sq ft per hr per deg temperature difference.

The above may be true or again it may be a "pipe dream." Why not try it out? One author says doubling the liquid velocity increases the heat transfer rate about 75 per cent while increasing it five times results in raising the heat transfer rate to about 360 per cent. It sounds reasonable and it may be right — or it may be screwball.

Cincinnati, Ohio IRA A. BUTCHER

PALERMO

(*Continued from page 78*)

cal precipitator located at grade level. The gases then pass from the constant-speed motor-driven induced draft fan and are discharged through a short length of breeching into a 250 ft masonry stack.

Each combination dust collector and electrical precipitator is designed to remove about 97 per cent fly ash from the stack gases.

(b) TURBO-GENERATOR EQUIPMENT — Steam is supplied from the boilers to 30,000 kw, 0.70 pf; 42,800 kva, 3000 rpm turbo-generator units, tandem compound double flow exhaust type, driving 10,500 v, 15 psig hydrogen-pressure-cooled generators with direct connected main and pilot exciters arranged lengthwise along the turbine hall. The condensing turbine has 22 stages with four extraction openings and is designed for 850 psig, 900 F steam at the throttle and is provided with extraction points at the 7th, 12th, 16th and 19th stages. The cooling water for generator hydrogen coolers, turbine shaft seals, turbine oil coolers, pulverizer fan bearings, boiler feed pump bearings and air compressors is supplied from a head tank located under the roof. Two cooling water pumps, each of 665 gpm capacity are used to circulate the condensate through the above equipment and two condensate-cooling heat exchangers operated in parallel in a closed circuit. For normal operation one pump will circulate the cooling water through the equipment while the second pump will serve as a standby. The cooling water for the heat exchangers is obtained from the condenser circulating water lines. Each turbine exhausts to 27,500 sq ft single-pass, cross-flow condenser equipped with divided water boxes and an internal cross-over valve. The condenser is designed

Principal Equipment—Palermo Steam Power Plant—Societa Termo-Elettrica Siciliana

Quantities Below for one Complete Unit: Boiler, Turbine, Auxiliaries, etc. Two Complete Units Provided.

STEAM-GENERATING EQUIPMENT

Boiler 1—Babcock & Wilcox Co. Single drum radiant type steam generator, 305,000 lb per hr continuously, 915 psi operating pressure, 910 F superheat outlet temperature when fed with 360 F feedwater, and when fired with pulverized coal. Heating surface 11,438 sq ft and heat liberation at 305,000 lb steam per hour = 17,400 Btu per cu ft per Hr.
Gross efficiency at continuous rating is 90 per cent.
Superheater is of the horizontal continuous tube type consisting of two sections with spray type attemperator between the sections for control of steam temperature. The economizer is of the continuous tube type. The flow of water in the economizer is counter flow in respect to the flue gases over the outside surface of economizer tubes in the top section and parallel flow in the bottom section.
Air Heater heating surface is 100,830 sq ft. The Air Heater is so arranged that one half can be shut off by dampers to permit washing and maintenance.
Pulverizers (3 per boiler)—Babcock & Wilcox Co. B & W Co. type E-64 mills, pulveri or fans, and pulverizer feeders.
Pulverizer Drives (1 per mill) Compagnia Generale di Elettricita, 125 HP, 600 rpm, 3000 v, 3 phase, 50 cycle, T.E.F.C. Induction Motor.
Pulverizer Fan Drives (1 per pulverizer fan)—Compagnia Generale di Elettricita. 150 HP, 1500 rpm, 3000 v, 3 phase, 50 cycle, T.E.F.C. Induction Motor.
Forced Draft Fan (1 per boiler)—American Blower Corp. 84,500 net cfm, SP = 12.3 in., Temperature 80 F.
Forced Draft Fan Drives—Compagnia Generale di Elettricita 300 hp, 1500 rpm, 3000 v, 3 phase, 50 cycle, T.E.F.C. Induction Motor.
Induced Draft Fan (1 per boiler)—American Blower Corp. 152,500 net cfm, SP = 10.2 in., Temperature 355 F.
Induced Draft Fan Drive—Tecnomasio Italiano Brown Boveri 500 hp, 750 rpm, 3000 v, 3 phase, 50 cycle, T.E.F.C. Induction Motor.
Soot Blower—Diamond Power Specialty Corp. Steam blowing type, air motor drive and controls.
Stack 1—Mariani Battista Masonry type, 250 ft high x 12 ft diameter at top.
Ducts & Breeching—Breda (Italian licensee of B & W Co.)
Combustion Control and Instruments—Bailey Meter Co.

POWER GENERATING EQUIPMENT

Turbine—Generator 1—General Electric Co. 30,000 kw Unit, 22-Stage Condensing turbine, 850 psi, 900 F steam at throttle, 4 heater extractions 7th, 12th, 16th, and 19th stages, exhausts to 1.68 in. Hg. Generators, hydrogen cooled. Generator rating 42,800 kva, 3 phase, 50 cycle, 10,500 v, 3000 rpm.
Condenser 1—Foster Wheeler Corp. 27,500 sq ft Cross flow Condenser, single pass, divided water boxes, spring supported; twin element two stage steam jet air ejector: inter and after condenser. Two single-stage steam-jet evacuators, one used as hogging ejector on steam side, one used as priming ejector on circulating water suction.
Circulating Water Pumps 2—Foster Wheeler Corp. Vertical, motor driven, mixed flow circulating water pumps. 22,000 gpm, 19 ft head.
Circulating Water Pump drives 2—General Electric Co. 200 HP, 600 rpm, 3000 v, 3 phase, 50 cycle.
Traveling Water Screens 2—Chain Belt Co. 22,000 gpm capacity. 8 ft wide copper baskets.
Traveling Water Screen drives 2—General Electric Co. 1½ HP, 1500 rpm, 220 v, 3 phase, 50 cycle.

FEEDWATER EQUIPMENT

Condensate Pumps 2—Foster Wheeler Corp. Horizontal 3-stage centrifugal type. Capacity 500 gpm, head 325 ft.
Condensate Pump Motor Drive 2—General Electric Co. 75 HP, 1500 rpm, 220 v, 3 phase, 50 cycle.
Drip Pumps 2—Dean Brothers Pumps, Inc. Horizontal 2-stage centrifugal type. Capacity 100 gpm, 350 ft. T.D.H.
Drip Pump Motor Drives 2—General Electric Co. 20 hp, 3000 rpm, 220 v, 3 phase, 50 cycle, Induction Motors.
Boiler Feed Pumps 3—Worthington Pump & Machinery Corp. Horizontal 6-stage centrifugal type. Capacity 700 gpm, head 2900 ft.
Boiler Feed Pump Motor Drives 2—General Electric Co. 700 hp, 1500/3700 rpm, 3000 v, 3 phase, 50 cycle.
Boiler Feed Pump Turbine Drive 1—General Electric Co. 700 hp, 3700 rpm, inlet Steam pressure 850 psi, 900 F, exhaust to atmosphere.
No. 3 Heater, 1—Foster Wheeler Corp. Closed Low Pressure Vertical heater, 984 sq ft heating surface. 203,310 lb per hr of condensate heated from 98.7 F to 169.3 F, 50 psig shell pressure, 200 psig tube pressure, steam extraction from 19th stage.
No. 2 Heater, 1—Foster Wheeler Corp. Closed Low Pressure Vertical heater. Total surface 1000 sq ft, drain cooler surface 100 sq ft. 240,090 lb per hr of condensate heated from 170.1 F to 215.9 F, 50 psig shell pressure, 200 psig tube pressure, steam extraction from 16th stage.
No. 1 Heater, 1—Foster Wheeler Corp. Closed Vertical high pressure heater, total surface 2200 sq ft. Drain cooler surface 175 sq ft. Desuperheat zone surface 151 sq ft. 278,500 lb per hr condensate heated from 284.3 F to 361.7 F, 200 psig shell pressure, 1500 psig tube pressure. Steam extraction from 7th stage.
Deaerating Heater 1—Worthington Pump & Machinery Corp. Vertical steam jet type deaerating heater Horizontal storage tank. 278,500 lb per hr of water deaerated to saturated temperature of steam at 52.6 psia. 10 min storage capacity. Steam extraction from 12th stage.
Evaporator 1—Foster Wheeler Corp. Capacity 10,000 lb per hr vapor, salt water feed, single effect, effective tube surface 1200 sq ft, 15 psig and 30 in. Hg shell pressure, 25 psig tube pressure, evaporating steam from 16th stage extraction.

COAL AND ASH HANDLING EQUIPMENT

Coal Handling Equipment

Coal Breakers—Pennsylvania Crusher Co. Torque breaker, grindability of approximately 45 capacity at 200 tons per hour.
Coal Scale (3 per boiler)—Richardson Scale Co. Stationary type, unit capacity 100 Kilos. hourly capacity 10 metric tons. Totally enclosed, dust proof, all electric automatic weighing hopper scales.
Ash Handling System, 1—Hydro-Ash Corp. Equipment includes ash hoppers, sluiceway equipment, fly ash lines to collectors and stacks, ash sump equipment, ash pit pumps.

MISCELLANEOUS EQUIPMENT

Turbine Oil Purification System 1—Bowser, Inc.
Condensate coolers (2 per unit)—American Locomotive Co. Two shells in parallel, 1200 sq ft effective surface, 125 psig shell pressure, 125 psig tube pressure.
Cooling Water Pumps, 2—Fairbanks-Morse Co. Horizontal single stage centrifugal pump capacity 665 gpm, discharge pressure 35 psig close coupled to 20 hp, 3000 rpm, 220 v, 3 phase, 50 cycle, Induction Motor.
Screen Wash Pumps, 1—Worthington Pump & Machinery Corp. Capacity 300 gpm, head 182 ft.
Screen Wash Pump Motor Drive, 1—General Electric Co. 20 hp, 1500 rpm, 220 v, 3 phase, 50 cycle, Induction Motor.
Transfer Pumps, 2—Food Machinery & Chemical Corp. Vertical, centrifugal type, Capacity 20 gpm, discharge head 325 ft.
Transfer Pump Motor Drive, 2—General Electric Co. 5 hp, 3000 rpm, 220 v, 3 phase, 50 cycle, Induction Motor.
High Pressure Chemical Feed Pumps, 2—Proportioneers, Inc. Simplex type, capacity 2.3 to 22.8 US. gph; maximum discharge pressure 1650 psig, 100 gal phosphate dissolving tank, with agitator.
High Pressure Chemical Feed Pump Motor Drive, 2—General Electric Co. 3 hp, 1500 rpm, 220 v, 3 phase, 50 cycle, Induction type.
Starch Feed Pumps & Drives, 1—Foster Wheeler Corp. Westac type SR-4R-8, turbine type, horizontal pump, 2 gpm cap, 80 ft discharge head with ½ hp, 1500 rpm, 220 v, 1 phase, 50 cycle Induction Motor.
Plant Air Compressor, 1—Termomeccanica. Horizontal, 3 cylinder, water cooled air compresser 8850 liters per min. capacity, 7 Kg per sq cm. pressure, aftercooler and 2 cubic meter air receiver.
Plant Air Compressor Motor Drive, 1—85 hp, 1500 rpm, 220 v, 3 phase, 50 cycle, Induction Motor.
Power House Crane, 1—Cantieri Riuniti dell' Adriatico Main Hoist 100 tons—Aux. 20 tons.
Evaporator Makeup Pumps, 2—Dean Brothers Pumps, Inc. Vertical, centrifugal, sump type, 80 gpm capacity, 50 ft. T.D.H.
Evaporator Makeup Pump Motors, 2—General Electric Co. 5 hp, 1500 rpm, 220 v, 3 phase, 50 cycle, Induction type.
Evaporator Blowdown Heat Exchanger, 1—Foster Wheeler Corp. 268 sq ft effective surface, 50 psig, shell pressure, 25 psig tube pressure.
Brine Pumps 3—Dean Bros. Pumps, Inc. Horizontal, centrifugal type pumps, 80 gpm, 60 ft discharge head.
Brine Pump Drives, 2—General Electric Co. 3 hp, 1500 rpm, 220 v, 3 phase, 50 cycle, Induction Motors.
Miscellaneous Tanks—Buffalo Tank Corp.
Combustion Control Air Compressor (1 for two units)—Worthington Pump & Machinery Corp. Horizontal, single stage, double acting, 78 cfm, 100 psig.
Combustion Control Air Compressor Drive, 1—15 hp, 1500 rpm, 220 v, 3 phase, 50 cycle Induction Motor.
Piping Fabricator—W. K. Mitchell Co.
Piping Erector—Breda (Italian licensee of B & W Co.)
High & Low Pressure Valves—Chapman Valve & Mfg. Co., Crane Co., Manning, Maxwell, & Moore, Inc., J. E. Lonergan Co., Henry Pratt Co.
Reverse Current Valves—Atwood & Morrill Co.
Control Valves—Fisher Governor Co., Leslie Co. Republic Flow Meters Co.
Air Check Valves—Williams Gauge Co.

ELECTRICAL EQUIPMENT

Station Service Transformers, 3—5000 kva, 3 phase, self-cooled, 10,500 v delta/3000 v delta, 50 cycle, askarel filled.
Station Service Transformer, 3—1150 kva, 3 phase, self-cooled, 3000 v, delta/240 v delta, 50 cycle, askarel filled.
Main Switchgear, 10,500 V—Pneumatically operated air blast circuit breakers, rated 1,500,000 kva interrupting capacity.
Station Service Switchgear—3000 v, air circuit breakers.
Station Service Switchgear—220 v, air circuit breakers.
Generator Excitation Switchgear
Generator Protective Equipment
Control Switchboard
Neutral Cubicle
Spare Exciter
Storage Battery—125 v.
Battery Charging Panel
Intercommunication System
Lighting Panels
Motor Control Centers
Relays and Instruments
Mechanical & Electrical Engineers—The Kuljian Corporation.
Architectural & Structural Engineers—Societa Progettazione Impianti Termoelettrici Industriali.
Constructors—Societa Progettazione Impianti Termoelettrici Industriali.

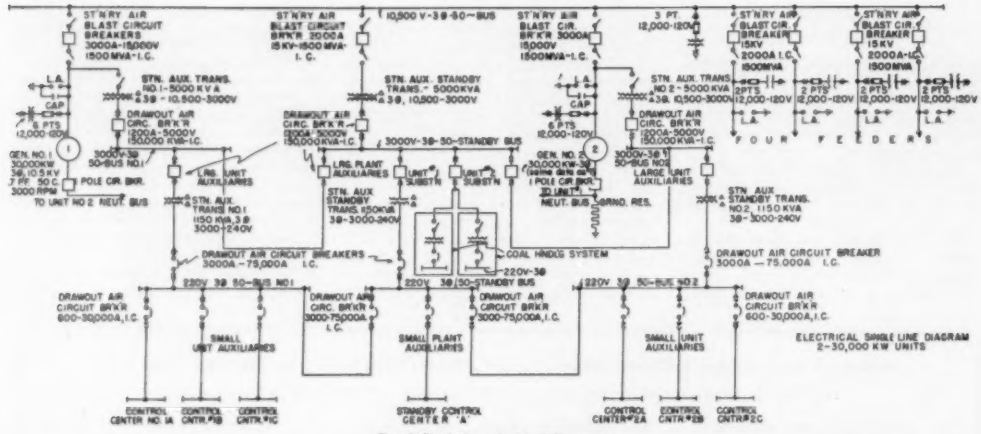


Fig. 4. Single line electrical diagram

to condense 202,810 lb of steam per hour when supplied with 42,600 gpm of circulating water at a temperature of 77 F. The condenser is spring supported. Two horizontal centrifugal condensate pumps are located beneath the condenser hot well each having a capacity to deliver 500 gpm of condensate against a total dynamic head of 325 ft.

The condenser hotwell level is maintained by throttling the discharge of the condensate pumps. In addition, a controlled recirculation line is provided from condensate pump discharge to the condenser hotwell. This combined system prevents cavitation, maintains a uniform hotwell level and prevents overheating of the condensate pumps.

Two vertical mixed flow type circulating water pumps of 22,000 gpm capacity having 19 ft total discharge head supply the condenser through two 36 in. cast iron pipes above the ground floor. The condenser discharges into two 36 in. similar pipes which pass into the discharge tunnel located beneath the ground floor. The circulating water pumps are located indoors adjacent to the condenser on the ground floor and can be serviced from above with the power house crane. The circulating water pumps are equipped with vertical drip proof squirrel cage induction motors.

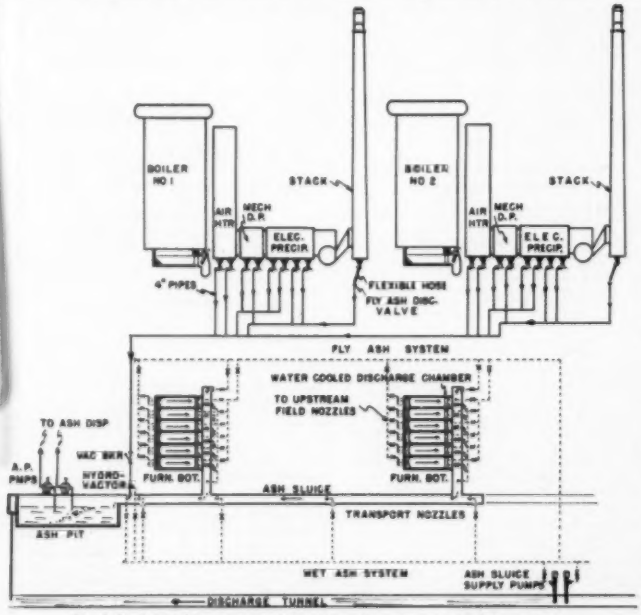


Fig. 5. Single line flow diagram of the ash handling system at the Palermo plant

(c) FEEDWATER CYCLE — A complete water study revealed that the best supply for boiler water make-up and station service would be the Mediterranean Sea water. The plant sanitary system will utilize the Palermo City water supply.

The feedwater system for each unit obtains its make-up in the form of steam from its unit salt water single effect evaporator. The warm salt water circulating through the condensate cooling heat exchangers is discharged into the sump for the evaporator make-up pumps to utilize the increased btu content of this supply over that of the water in the intake tunnel. The overflows from the sumps are discharged directly into the discharge tunnel. Each sump is provided with two vertical evaporator make-up pumps (one spare) which pump the make-up through an evaporator blow-down heat exchanger for additional heat gain and then into the evaporator. Evaporator blowdown is pumped by brine pumps through the evaporator blowdown heat exchanger and into the discharge tunnel. A batch type feed system is provided for injecting starch feed into the evaporator make-up water for reducing salt concentration. Evaporator water level is maintained by means of weir level control. A manually controlled throttling valve is on the evaporator feed inlet which once set provides for an overflow of twice as much blowdown from the feed water supply as is evaporated. The feed water cycle employs one vertically mounted high pressure closed feed water heater, a floating type deaerating heater and two low pressure vertically mounted closed feed water heaters. Make-up is supplied to the deaerating heater in the form of steam from the horizontal evaporator. All of the closed feed water heaters are mounted vertically and are located in the heater bay. Steam for feed water heating is bled from the turbine at the four extraction points selected to give the most economical

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Send for Betz Technical Paper #121, "How Filming Amines Prevent Steam and Return Line Corrosion."

*U. S. PATENT 2,460,259
CANADIAN PATENT 461,238

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regenerative cycle under the full load conditions. The 7th-stage heater is equipped with a desuperheating section having a terminal difference of minus 3 deg F and an integral drain cooler having a terminal difference of 10 deg F. The 16th-stage heater has a 5 deg F terminal difference and is equipped with an integral drain cooler having a terminal difference of 10 deg F. The 19th-stage heater has a 5 deg F terminal difference. The drains from the 19th-stage low pressure heater are pumped by heater drip pumps ahead of the heater into the condensate system. Drains from the 7th- and 16th-stage heaters are flashed into the deaerating heater and 19th-stage heater respectively. All feed water heaters, deaerators, and evaporator blow down heat exchangers are provided with ample by-passes so that any of this equipment may be taken out of service for repairs, cleaning, etc. and still not effect the station heat rate materially. The evaporator is provided with a fresh water connection in the event that the present Palermo City water supply, which is now limited, becomes increased and more available.

The full capacity centrifugal volute type boiler feed pumps are located on the ground floor and pump condensate from the deaerating heater through the high pressure heater to the economizer. One of the two motor driven pumps is operated during full load conditions, while the remaining motor driven pump is a standby. There is also provided a standby turbine driven pump to comply with the local codes.

Each pump casing is of 5 per cent chrome steel and is horizontally split with the suction and discharge nozzles cast integral with the lower half, thereby permitting for repairs without disconnecting piping. Pump impellers are 13 per cent chrome stainless steel, arranged back to back to accomplish hydraulic balance over entire operating range. Automatic boiler feed pump recirculation bypass controls are provided, thereby affording pump protection at low load.

A 10,000 gal condensate sump tank is connected with the feed water inlet to the deaerating heater. Low water in the deaerating heater causes the condensate transfer pumps to pump water into the deaerating heater thereby restoring its level. Should the deaerator level rise above normal, the deaerating heater regulating valve, which is in the condensate transfer pump circuit, is automatically closed permitting the deaerator water level to lower to normal. In addition a 75,000 gal outside condensate storage tank is provided for use should the level in the condensate sump tank become too high or low: also when draining the boiler during shut-down, the boiler water is saved in the condensate storage tank. For filling up of the boiler before start up, a line is provided between the condensate storage tank and the boiler feed pump suction header.

The main building dimensions are approximately 230 ft square which includes a boiler bay approximately 100 ft wide and 115 ft high. The turbine bay is approximately 60 ft wide and 85 ft high, and in addition are bays for mechanical and electrical equipment. The turbine bay accommodates a craneway over this area of 100 ton capacity crane. The upper floors and platforms are serviced with an elevator in addition to stairways.

The main floors are generally reinforced concrete and the use of metal grating floors are confined to movable floor areas as also the boiler platforms for the perimeter of boilers. The coal bunkers are also of reinforced concrete with sloping side walls at bunker outlets.

Generally, the entire structure is of the rigid frame design of reinforced concrete, capable of sustaining all loadings and the forces set up by possible volcanic or earthquake action. Main structural columns in turn are supported by reinforced concrete piling with depths as required by the earth composition.

The turbo-generator foundations are also of reinforced concrete construction, and entirely independent of building structure. It will be noted that the entire structural design influences the architectural appearance in which it is purely functional in design; the structural members are frankly exposed as also are the sloping stair stringers exposed on the various elevations.

The areas or panels between the exposed vertical and horizontal structural members are composed of a combination of masonry, metal windows, ventilating louvers, and glass block. A feature of the design covers the distinctive European methods in which the maximum strength with the minimum use of materials is paramount.

Electrical Equipment

GENERATOR CONNECTIONS — The generator is a hydrogen-cooled machine rated at 30,000 kw, 42,800 kv at 0.70 pf, 10.5 kv, 3 phase, 50 cycle, connected wye. By increasing the hydrogen pressure to 25 lb a rating of 44,700 kva at 0.70 pf is obtained. The machine has a short circuit ratio of 0.80.

The power is generated and distributed from the plant to the City of Palermo at 10,500 v. Four outgoing underground feeders have been provided. Each generator and its associated equipment is a unit, and is independent of the other units in the plant. All connections are kept as short and direct as possible.

The 10,500-v switchgear is indoors and is located in an electrical bay on the east side of the turbine room. The connection from the generator to the switchgear is made with a metal enclosed, segregated phase bus duct, rated 15-kv and 3000 amp. This bus is tapped and a bus connection made to the 5000 kva, 10,500/3000-v station service transformer, which is located on the ground floor below the bus run. This transformer supplies the unit auxiliaries. Another bus connection is carried from the generator to a metal enclosed cubicle on the ground floor, below the bus run, which contains the potential transformers for metering and the voltage regulator as well as the lightning arresters and capacitors for surge protection.

The neutral lead of each generator is connected through a single pole circuit breaker to an insulated neutral bus. This bus is connected to the station ground through a grounding resistor rated 2 ohms, and 3000 amp for 10 sec. The neutral circuit breakers are interlocked so only one generator may be grounded at a time.

EXCITATION SYSTEM — The generator is normally excited by a 175-kw, 250 v exciter which is directly coupled to the generator shaft. This exciter in turn is excited by a direct driven pilot exciter rated 4 kw and 250 v. A motor driven spare exciter has been provided which serves as a spare for the unit exciters. This spare exciter is 175 kw, 250 v, self excited, and is driven by a 300 hp 3000 v induction motor.

The main leads of both the main and spare exciters are connected to the generator field, each through a DPST electrically operated air circuit breaker. The circuit breakers are interlocked so that the spare exciter can only be used for one unit at a time.

The generator voltage is controlled by an indirect acting, exciter-field-rheostatic-type voltage regulator. This regulator operates the motor driven exciter field rheostat.

The field circuit breakers, motor operated rheostats, and field discharge resistors are all mounted in a metal enclosed cubicle located on the turbine room floor.

10,500-VOLT SWITCHGEAR — The 10,500-v switchgear contains the circuit breakers for the two generators, the reserve station service transformer, and the four 10,500-v feeders. This switchgear is metal clad. The breakers are pneumatically operated air blast breakers and are provided with isolating disconnect switches. Barriers are provided to give complete phase segregation. The compressed air for the operation of these breakers is supplied by two motor driven air compressors located on the ground floor below the switchgear.

Each of the four 10,500-v feeders is run in bus duct from the switchgear to an entrance cubicle on the ground floor below the switchgear. These entrance cubicles each contain three lightning arresters for surge protection, a potential transformer for synchronizing, and six single conductor potheads for terminating the underground feeder cables.

STATION AUXILIARIES — Each generating unit is provided with a 3000-v

(*Continued on page 120*)

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There is nothing new about the use of synchronous motors to improve the power factor of industrial power systems. By properly controlling the field current in a synchronous motor it is possible to make such motors supply the magnetizing current for induction motors on the system that, otherwise, would have to be supplied by the main generators. This is what is done in the installation which Mr. Gusler describes in this article but the real feature of interest is his detailed description of just how they went about putting an old motor and an old generator to good use. As he points out, there probably is old equipment of this kind in many plants that, with a little headwork and some physical effort, could be made to pay real dividends in reducing the cost of power

A Synchronous Motor At Work

By DENARD L. GUSLER

IN A RECENT ARTICLE "Power Generation from Wood Waste" [1] the writer described the failure of a belted engine-generator combination. Although the engine has long since gone into scrap metal the generator is still at work despite its fifty odd years of age. The story of how this old generator continues in operation should prove of value to others. In a large plant that generates its own power there is frequently an obsolete generator in good condition that can still be made to do a useful work.

The generator mentioned above was rated at 550, 315 amps, 0.8 pf, 240 kw, and 450 rpm. It was mounted on a base supporting three pedestal bearings. On the same shaft a 48 inch pulley was installed between the center and remaining outside bearing.

For years after the old engine was shut down the generator remained on its foundation and sat idle. In the

meantime an air compressor wore out leaving a synchronous motor in good condition.

About that time 120 cycle current was coming into general use to operate shaper and moulder heads in the furniture factory. For the generation of the high frequency current it was customary to purchase motor generator sets called frequency converters. In considering the problem as it applied to his plant it occured to the Chief Electrician that he could take his synchronous motor which was rated at 550 v, 100 amp, 1.0 pf, 225 rpm and have it rewound for the necessary 440 v. Then, if he rotated it at 450 rpm it would give him 120 cycle current.

The converter generator could then be installed in place of the pulley on the old generator shaft. By operating the old generator as a synchronous motor and synchronous condenser combined, the high frequency generator would have a prime mover at the necessary speed. This was done and for years the machines operated in this manner. The old generator switchgear was used without benefit of overload or under voltage protection. During the interval of time

[1] April 1951 Issue, p. 60.

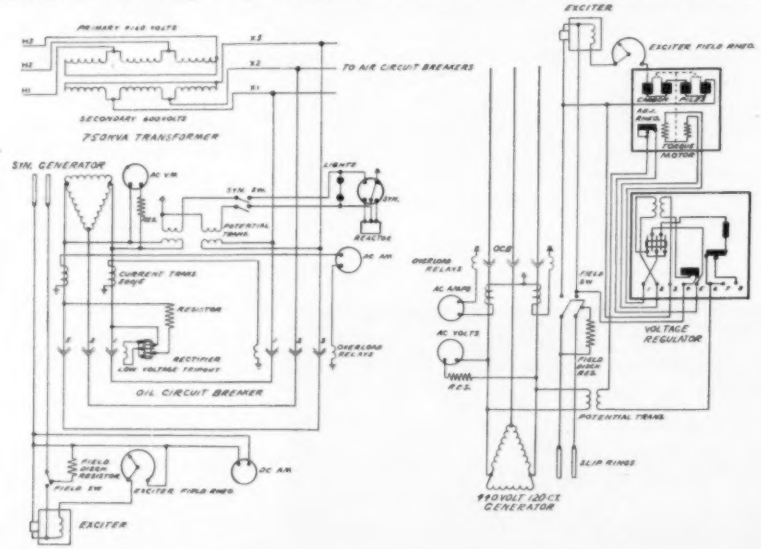

Fig. 1. Wiring diagram showing how the machines are connected. It will be noted that the only satisfactory place that the synchronous motor could be connected into the new transformer bank was on the 600-v bus between the air circuit breakers and the transformer secondary

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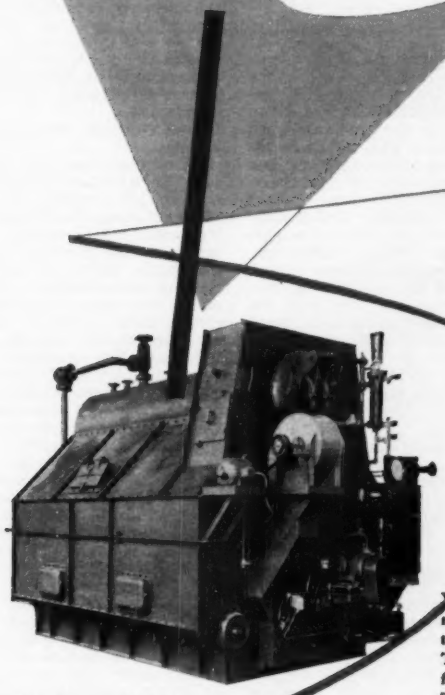

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involved, the switchgear deteriorated into a very unsatisfactory condition and recently it was necessary for the writer to design and build a new switchboard and at the same time to re-connect the old generator to serve a new indoor bank of transformers. It was intended that existing equipment lying around the plant would be utilized wherever possible.

Since it was virtually impossible to trace the old wiring the first step was to draw a schematic diagram of the necessary electrical connections. The new transformer bank was rated at 750 kva, 4160 v on the primary and 600 v on the secondary side. It was to supply the factory through four air circuit breakers. The diagram is shown in Fig. 1.

The second step was building a switchboard as shown in Fig. 2. The switchboard was welded together out of angle iron and 10 gage black sheet iron. The necessary openings were cut out and holes drilled for the installation of switches and instruments. The switchboard was set up, conduits run and wiring installed where possible. Then, on a week end, the change from the old to the new arrangement was effected.

It will be noted from Fig. 1 that about the only satisfactory place that the synchronous generator could be connected into the new transformer bank was on the 600 v bus between the air circuit breakers and the transformer secondary. The circuit was directly through an oil circuit breaker to the generator. We were able to find all the necessary instruments and accessories. The oil circuit breaker had 5 amp trip coils. We then installed current transformers with a ratio of 300 5 amps and put an ammeter in series with one of the trip coils. An old a-c voltmeter in good condition was installed with a resistor in series. Two potential transformers from the previous synchronizing circuit were installed as shown and connected through a switch to synchronizing lights. A synchroscope was found with its reactor but without a diagram for connections. By a few simple experiments the proper connections were worked out and the synchroscope was installed in parallel with the lights. The exciter circuit is a general arrangement without the ammeter shunt in the circuit. I assume that the meter has its own shunt in the instrument case. We also installed a low voltage trip-out which is very necessary on a synchronous generator

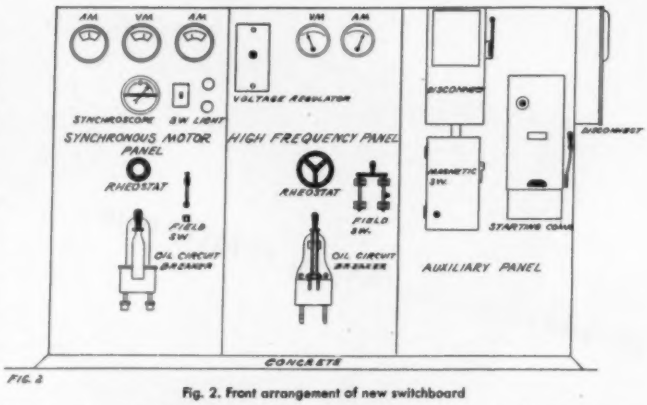

FIG. 2

Fig. 2. Front arrangement of new switchboard

in case of power failure. If the oil circuit breaker remains closed when power is restored a tremendous current is generated due to application of the power to the generator when it is out of phase. This will cause the circuit breaker to overload and trip out at the generator or somewhere on the system. The low voltage trip-out consisted of a rectifier and resistor connected to a coil. The coil magnetized and held in a weighted disk that, when de-energized to some extent, would fall and kick out the trip lever.

The procedure for the high frequency generator was almost identical with that of the synchronous generator with the exception of the synchronizing circuit and the installation of a voltage regulator. It would seem unlikely that current transformers with a ratio of 300/5 amp would work satisfactorily on a generator rated at 100 amp. In the first place the generator will carry more than its rated load. Just how much more is not certain but it is considerable. Then the old type overload trip coils have a small plunger that can be adjusted by means of a calibrated screw. We set the adjustment at a minimum then gradually raised it as the switch tripped out.

Automatic voltage regulation was necessary since the generator is meeting the demands of a variable load imposed by many machines. The voltage regulator was connected as shown and is extremely satisfactory.

Both exciters are driven by a single induction motor directly coupled to one exciter and V-belt connected to the other. The synchronous generator is started by an induction motor through a V-belt drive. It does not have the necessary winding to be self-starting.

The starting proceedure is as follows:

All oil circuit breakers are tripped out. The exciter field rheostat of the synchronous generator is turned to zero excitation. The induction motor is operated on its base by an eccentric cam to tighten its belts. The motor is then set in motion by operating the starting compensator. When the motor has come up to speed the compensator is locked in and the generator is now rotating at about 475 rpm. The operator turns the theostat and adjusts the voltage on the synchronous generator to the proper value. He then flips on the switch to the synchroscope. After that he trips out the manual starting compensator and returns to the oil circuit breaker as the generator slows down. Synchronous speed is approached and at the instant of phase balance he closes the switch. The generator is now floating on the line. He closes the circuit breaker of the high-frequency generator and it is ready for service.

We now come to the second phase of the synchronous generator operation which is that of correcting the power factor. In fact that is just about its most important function. By manual adjustment of the exciter field rheostat it is possible to obtain almost any desired power factor up to unity. Since load conditions vary it is necessary for the operator to adjust the rheostat from time to time.

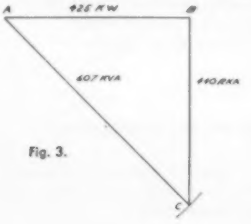

Fig. 3.

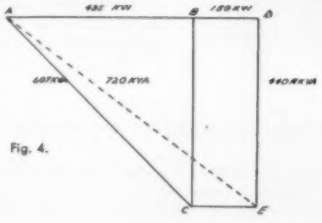

Fig. 4.

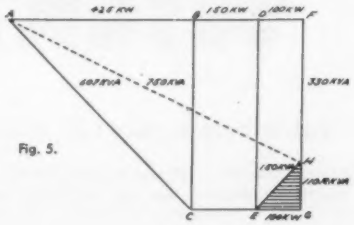

Fig. 5.

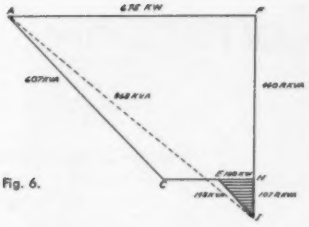

Fig. 6.

To adequately describe the function of the generator in the system as a synchronous condenser it will be necessary to take into consideration a given condition. When installing static condensers the original power factor is determined under the maximum load conditions and the proper amount of reactive kva is installed. The power factor will then change if the proper voltage is maintained on the generator as the load varies. This is also true with the synchronous condenser with a given setting of the rheostat; however, under different load conditions the rheostat can be adjusted for the desired power factor. On the installation under consideration when the power factor approaches unity considerable heat is dissipated by the generator.

For those who might wish to make their own calculations and installation, a general induction motor load condition is shown in Fig. 3. The factory load is 425 kw at 70 percent pf. This is represented by horizontal line A-B drawn to a desired scale. Vertical line B-C is drawn to an undetermined length. Now, we calculate the kva by dividing the kw by the power factor. Thus: $\frac{425}{70} = 607$ kva. Using a pair of dividers from point A to a scale of 607 we strike an arc intersecting line BC. Scaling B-C we find that the reactive kva is 440.

The transformers under consideration operate a synchronous motor of 150 kw driving an air compressor. This motor operates at unity power factor. To show this motor in the circuit the horizontal line A-B is extended as shown in Fig. 4 to D. Point C is extended horizontally to E. From point E we now draw a line to A. Scaling this line we arrive at the value of 720 kva. $\frac{575 \text{ kw}}{720 \text{ kva}} = 79$ percent pf. Thus we find that the addition of the synchronous motor has improved the power factor.

We now add the synchronous generator driving a 100-kw load as it ordinarily exists in the circuit when set to provide a power factor of 90 percent. In Fig. 5 the horizontal line is extended as shown from point D to F. A power triangle is now drawn as in Fig. 5 for the synchronous condenser when operating at a leading power factor of 66.7 percent. This triangle is drawn vertically as shown

(*Continued on page 109*)

GOOD TEMPERATURE REGULATION MEANS FEWER HEADACHES

In Power Plants all over the world, you will find Foster Temperature Regulators controlling temperatures of liquids and gases on heating and cooling equipment such as fuel-oil heaters; storage type water heaters, evaporators and cooling systems. The reason for this acceptance is that they offer a simple, dependable answer to accurate, automatic temperature control. They do their job well, with a minimum of maintenance.

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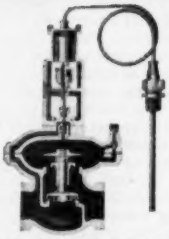
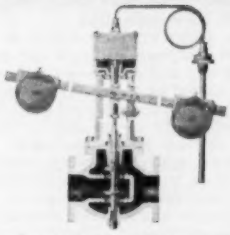
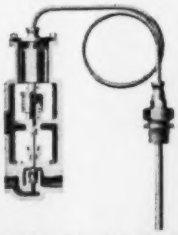


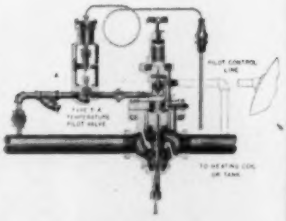
The Foster Type 34-T controls temperatures within approximately 1° F plus or minus, using steam or gases as heating medium. Internally pilot-operated, diaphragm actuated; valve travels from shut-off to full opening with relatively small temperature change.



The Foster Type T-3 controls temperatures within 3° to 5° F, plus or minus, using steam, water or other liquids and gases as heating or cooling medium. Handles large volumes with low pressure drop across double seats.



The Foster Type T-4 controls temperatures within plus or minus 5° F, using small volumes of steam, water or other liquids or gases as heating or cooling medium. Direct-acting, single seated for tight shut-off.



The Foster Type T-10 combination temperature and pressure regulator permits safe use of steam at pressures considerably higher than the shell of the heated vessel is built to withstand. Adjustable for both temperature and pressure.

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Plant Stops Return Line Corrosion—Saves $14,200 a Year

By **ERLE ELLIOTT**, Supervisor of Heat, Power and Utility Services, Glenn L. Martin Co.

and

PHILIP J. GAUGHAN, Chemical Engineer, W. H. & L. D. Betz

Return line corrosion was serious problem in extensive system of Glenn L. Martin Co.'s great plant near Baltimore. . . . Corrosion test program was carried out, also mechanical changes and preventive maintenance. . . . Filming amine treatment applied. . . . Tests show corrosion practically eliminated after two years. . . . Results: Save 6000 lb per hr of steam to factory; reduce maintenance time from 48 to 16 man-hours per day; save equivalent of 475 ft of 2-in. pipe per year. . . . Combined preventive maintenance and chemical treatment savings: $14,200 a year

GLENN L. MARTIN CO., located near Baltimore, Md., manufactures civilian and military aircraft, as well as numerous other types of equipment related to the aircraft industry. Its plant is quite extensive in area, containing many large buildings for manufacturing and assembling the finished products. Because of the extensive steam distribution and return condensate systems, severe maintenance problems were caused by corrosion. The remedies set forth here were used to correct these difficulties.

The boiler system consists of one B & W low-head Stirling boiler rated at 336 bhp and one Keeler CP boiler rated at 400 bhp. Operating pressure is 125 psi and make-up varies from approximately 45 per cent to 75 per cent of the boiler feedwater. An elaborate system of return condensate lines is installed, consisting of numerous condensate receivers and condensate pumps, to return the maximum amount of condensate to the boiler system.

Return line corrosion was recognized as a serious problem several years ago and a systematic program was planned to reduce metal losses to a minimum. Pipe sections removed from the system showed deep grooving as well as pitting, indicating that corrosion was due to both dissolved oxygen and carbon dioxide in the return condensate. This condition is readily noted in Figs. 1 and 2. Severe corrosion at threaded connections as well as line blockages were also experienced. Figure 3 shows a pipe coupling removed from the condensate system, illustrating corrosion of the threads.

Source of the dissolved oxygen in the return condensate system could not be attributed to the boiler system, since the boiler feedwater is deaerated and sodium sulfite is fed continuously to the heater effluent to maintain proper sulfite residuals in the boiler water. The carbon dioxide concentration of the steam varies from 14–27 ppm, depending on fluctuations in the raw supply and the percentage of condensate returned to the boiler feedwater system. A program of testing for dissolved oxygen, carbon dioxide, ammonia and iron at all condensate receiver stations was placed in effect.

Mechanical Improvements

The chemical testing program re-

Fig. 1. Before chemical treatment; top and bottom sections of a 2-in. condensate line, 10 in. long, extra heavy pipe, removed from system. Bottom half at right

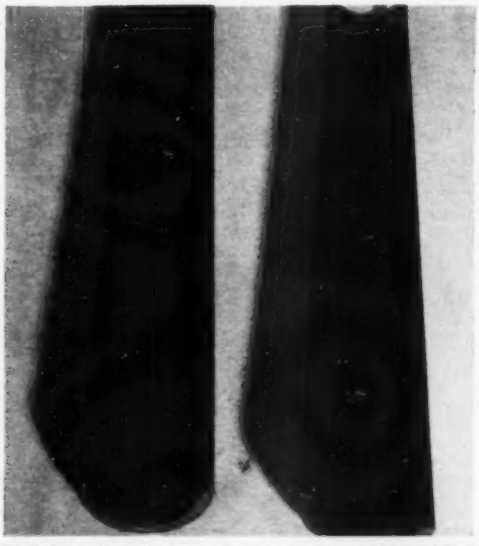


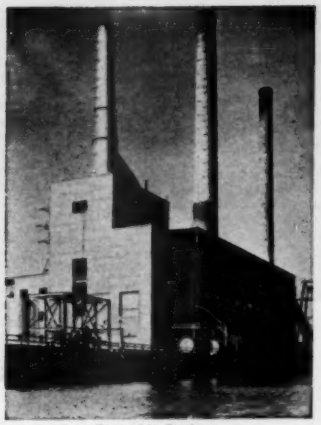
Fig. 2. Before chemical treatment; top and bottom sections (bottom half at right) of 2-in. condensate line, 18¾ in. long, extra heavy pipe, removed from system

Hookers Point Station, Tampa Electric Company

Possum Point Station, Virginia Electric & Power Co.

Louisiana Station, Gulf States Utilities Company

Venice No. 2 Plant, Union Electric Power Company



Riverside Station,
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Table I. Corrosion data before chemical treatment

Period of Specimen Exposure, Weeks	Weight Loss in Mg	Average Penetration, Inches per Year
2	369	0.0250
2	443	0.0300
4	600	0.0203
4	629	0.0213

Table II. Corrosion data two weeks after starting Permacol

Period of Specimen Exposure, Weeks	Weight Loss in Mg	Average Penetration, Inches per Year
2	114	0.0078
2	124	0.0084
4	234	0.0080
4	238	0.0081

Table III. Corrosion data 6 months after starting Permacol

Period of Specimen Exposure, Weeks	Weight Loss in Mg	Average Penetration, Inches per Year
2	5	0.0003
2	4	0.0003
4	3	0.0001
4	1	0.0000

Table IV. Corrosion data 2 years after starting Permacol

Period of Specimen Exposure, Weeks	Weight Loss in Mg	Average Penetration, Inches per Year
2	5	0.0003
2	1	0.0000
4	2	0.0000
4	3	0.0001

vealed that oxygen was being absorbed into the condensate at the condensate receiver stations. Check valves were therefore placed in the vents of all condensate receivers to eliminate this source of contamination.

High-pressure returns had been injected into the discharge piping of the condensate pumps, with failures resulting at these points. This system was changed to one involving a flash tank for high-pressure returns, which, in turn, discharged liquid condensate to the various condensate receivers.

All traps and strainers throughout the extensive piping system were cleaned periodically to prevent blow-by of steam caused by collection of corrosion products on the seats. Observations of the traps showed that severe scarring of the seats and orifices had taken piace, causing a continuous maintenance problem. Approximately one year was required under the normal maintenance program to clean all the traps in the system.

The return line corrosion taking place did not seriously affect production of any manufactured materials, but it did necessitate emergency repairs, with consequent inconveniences. In addition, since condensate lines were replaced regularly, condensate was lost during these repair

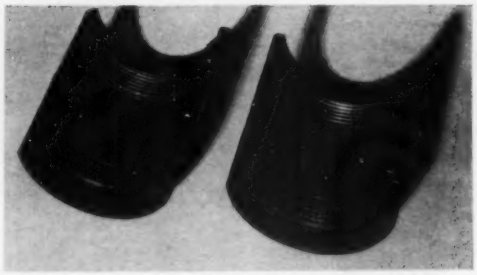

Fig. 3. Open half view of a 2-in. extra heavy pipe coupling, 3½ in. long, mounted horizontally in condensate line. Sectioned to show thread corrosion

operations, resulting in some difficulty in control of boiler feedwater treatment and of blowdown.

Results of these mechanical changes were a reduction in maintenance time from 48 man hours per day to 32 man hours per day. It was still believed, however, that return line corrosion was sufficiently serious to give consideration to chemical treatment in order to further reduce corrosion. Although piping of all sizes failed, it was estimated that the total losses were equivalent to 500 ft of 2-in. piping per year, even after all mechanical changes were made.

Test Specimen Program

In order to quantitatively determine the rate of corrosion, by-passes were installed in the system, into which corrosion test specimens could be inserted. Figure 4 illustrates the design of test specimen by-pass used. The test specimens were of low-carbon steel, each with a total area of 3 sq in. Four test specimens were inserted in each by-pass, two specimens being removed at the end of two weeks and the remaining two specimens being removed at the end of four weeks. The most severe corrosion was taking place in the piping after the largest receiver into which most of the other receivers discharged. Since the flow rate was highest at this point, data secured from test specimens installed in this section were used as a basis on which the effectiveness of chemical treatment was judged.

Table I shows the results of the corrosion tests with all mechanical changes completed, but prior to the application of chemical treatment. These test results were in agreement with plant experience, in that high metal losses were shown. The application of chemical treatment to reduce these metal losses and decrease maintenance costs was therefore considered.

Chemical Treatment Results

The chemical treatment applied is known as Permacol (commercial dispersion of octadecylamine). This material is a film-forming amine which functions by developing a non-wettable film barrier between the metal surfaces and the corrosive condensate. The protective film is resistant not only to attack by carbon dioxide, but also by dissolved oxygen.

Permacol was applied to the system for two weeks before another set of test specimens were inserted in the system. This action was taken in order to obtain distribution of Permacol throughout the extensive piping system. Results of the corrosion test after feeding the treatment for

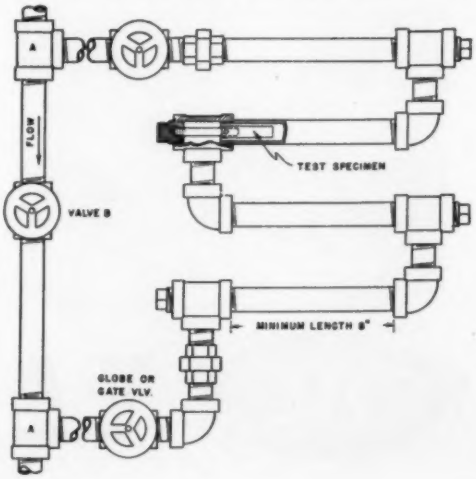

Fig. 4. Design of test specimen by-pass used in corrosion testing program

All piping and valves ¾-in. iron or steel. Four test specimen holders inserted, as shown in cross-section, in each of four tees.

Test specimens of low carbon steel, each of 3 sq in. total area.

Where main line is larger than ¾ in. tees A should be of proper size with reduction to ¾ in.

By-pass installed in line at point of good flow and where corrosion has been experienced, so that specimens are continuously submerged.

In large lines, valve B is throttled and number of turns from closed recorded, so conditions can be duplicated.

two weeks are shown in Table II. Although the test results showed an immediate reduction in the rate of corrosion of approximately 66 per cent, it was believed that even better results would be obtained after treatment had been in use a longer period of time. Corrosion tests were therefore continued in order to determine the validity of this theory. Test results after feeding Permacol to the system for six months are shown in Table III and indicate practically complete elimination of corrosion after complete film formation throughout the entire piping system. Table IV shows the results of an identical corrosion test after two years of application.

Since the feeding of Permacol was started, there has been a reduction in maintenance time from 32 man-hours per day to 16 man-hours per day. At the present time, traps and strainers are inspected and cleaned every two years and it is believed that this time will be extended in the future. During the initial period of feeding Permacol, it was found that considerable sloughing off of old corrosion products was taking place, and it was necessary to clean strainers frequently. At the present time, however, no difficulty is being experienced with plugging of strainers or regulators.

Results of Program

Pipe losses at the present time have been reduced to the equivalent of 25 ft of 2-in. pipe yearly. When any alterations are necessary, the adjacent piping is carefully inspected. Previously, all condensate piping showed a considerable build-up of corrosion products. At the present time, however, the appearance of the piping is clean and the non-wettable Permacol film is present. At points where previously deep pitting and grooving occurred, the products of corrosion have since sloughed off and corrosion has been arrested.

Based on regular inspection of the boilers, there has been no noticeable effect on the internal conditions. It should be noted that considerable steam savings were secured with this program of preventive maintenance, including inspections and cleaning. Adjustment of load demands along with the improved mechanical arrangement and chemical treatment has resulted in a saving of approximately 6000 lb per hr of steam under identical demand conditions. In other words, where originally 40,000 lb per hr of steam were required for a certain load demand, only 34,000 lb per hr are now required. One of the principal reasons for this reduction in steam consumption has been the elimination of blow-by of steam past the traps, caused by corrosion and clogging of the seats with corrosion products. This saving in steam consumption, together with some adjustment in load demands, made operation of two boilers at one time unnecessary.

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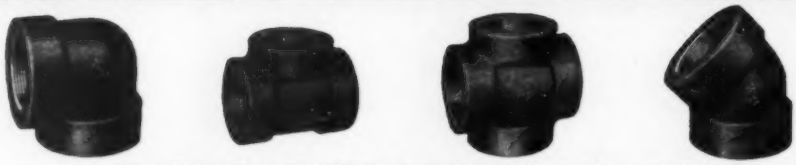

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Application of chemical treatment has resulted in the estimated saving of the equivalent of 475 ft of 2-in. insulated pipe or approximately $800 per year. Labor savings amount to $7300 per year based on 16 man-hours saved per day at $1.75 per hour and 260 working days per year. The total cost per year for Permacol is $1200, which results in a net saving of $6900 per year.

By the initial program of revising the mechanical installations, as well as the continuous preventive maintenance program, $7300 per year was saved. The combination of both preventive maintenance and chemical treatment, therefore, resulted in a net saving of $14,200 per year. These savings, plus the reduction in steam consumption secured as a result of the program, illustrate the economics that can be secured through the application of sound engineering principles.

SYNCHRONOUS MOTOR

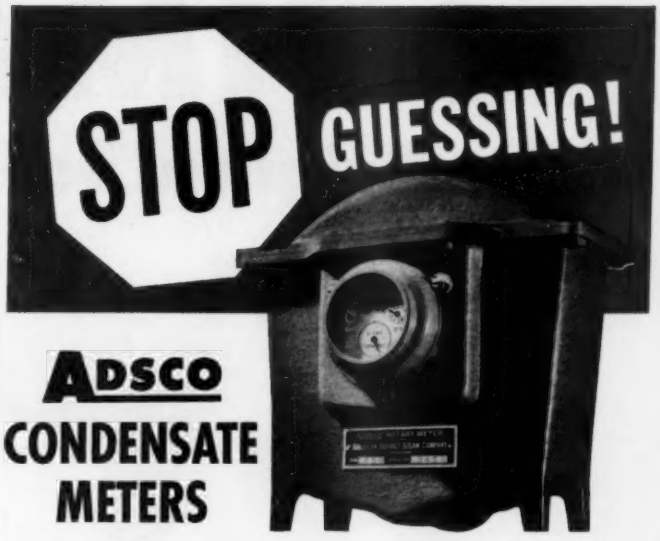
(*Continued from page 103*)

shaded in Fig. 5. $\frac{100 \text{ kw}}{66.7\% \text{ pf}} = 150$ kva. Scaling G-H we find that the reactive kva is 110. Since power factor is leading we can deduct this value from the previous lagging rkva of 440 leaving 330 rkva. Drawing a line from point H to A and scaling we obtain a value of 750 kva.

The transformer bank is thus operated at its normal rating although it is now carrying 675 kw. At unity power factor it would carry 750 kw.

If we had elected to operate the 100 kw high frequency generator with an induction motor at 70 percent power factor the results would have been quite different from the values given in Fig. 5. In Fig. 6 a triangle is shown to illustrate this condition. The basic power triangle is drawn as in Fig. 5. The triangle for the induction is represented by the shaded portion. $\frac{100 \text{ kw}}{70\% \text{ pf}} = 143$ kva. Proceeding as previously discussed and scaling H-I we obtain a value of rkva of 107. Since the power factor is now lagging this value must be added to the 440 rkva making a total of 547 rkva. Drawing a line from point I to A and scaling we find the load on the transformer bank to be 868 kva and the power factor is 70 percent. Thus the transformer bank would have been considerably overloaded.

It is readily apparent that by use of reasonable judgment and materials that are sometimes on hand or generally available from second hand sources an arrangement can be worked out that will materially improve existing electrical arrangements. This improvement as outlined is reflected in putting to a maximum use existing equipment and reduction in power costs by a better power factor.



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EASILY SERVICED Disassembly for inspection or cleaning is simple and easy. With manifold, meter can be removed without disturbing the connecting piping.

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500	11⅝	12¾	10⅛	41
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1500	17⅛	16⅞	13	80
3000	23¾	25⅛	15¾	171
6000	23¾	25⅛	22⅝	230
12000	31	31⅛	27⅝	453

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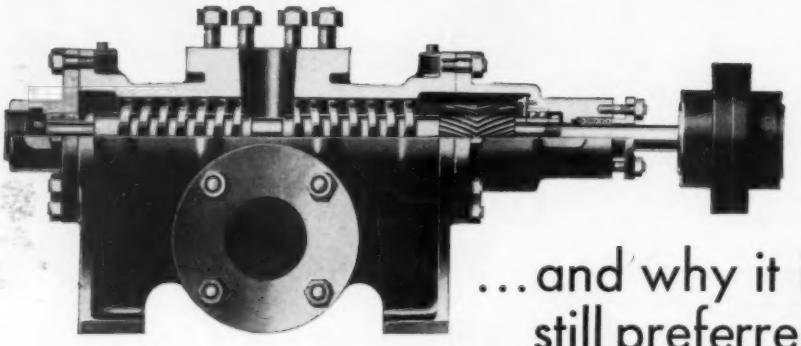

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TELLS

How to Clean Your Turbine Lubricating System After Service

Detailed methods and instructions given here are the recommended practices prepared by the Joint ASTM-ASME Committee on Turbine Lubrication . . . They are taken from the author's paper * presented before the Annual ASME meeting in New York, December, 1950

CLEANING OF TURBINE LUBRICATING SYSTEMS after service should be accomplished through co-operation of turbine builder, operator and oil supplier. No phase of this work should be undertaken without thorough understanding of possible effects on subsequent operation of the unit, nor should it be entrusted to inexperienced persons without adequate supervision.

Why Must You Clean Lubricating System?

Trouble-free operation of steam turbines depends to a large extent on cleanliness of the lubricating oil system.† After use, deposits may accumulate in such systems as a result of contamination by dust, dirt, lint, pulverized coal, fly-ash, rust, welding beads, scale, water, emulsions, insoluble oil degradation products and combinations of these. In addition, there is always the possibility of other materials in the surrounding atmosphere getting into oil system: cement dust, chemicals, etc.; as well as the possibility of other foreign materials such as rustproof or pipe thread compounds, gasket or lagging materials, or cutting oil being left in the system after repairs or changes.

These foreign materials may clog oil lines, with resultant bearing damage or failures, fouling of governors, deposit on coolers, etc. Also, they may cause foaming, emulsification of the oil with water and accelerated oil degradation. Blistering or flaking of permanent-type protective coatings in tanks may occur; the loosened material may clog the lubricating system.

Mere draining of the oil from the system may remove only a small portion of the deposits described above.

Adequate oil purification during circulation, through use of oil purifying equipment of proper size and design, will go far to prevent build-up of insoluble foreign matter in the system. Periodic inspections indicate whether proper maintenance practices are being followed and should be supplemented by other inspections when serious variations in operating data are observed.

When Must You Clean?

Turbine manufacturers usually recommend that within the first year of operation, a new turbine be taken down for complete general inspection. This offers excellent opportunity for also inspecting the oil system for evidences of deposits, corrosion and abnormal wear.

When a turbine is placed in service, close watch should be kept until operating conditions have stabilized. Thus, normal oil temperatures to bearings, coolers and other parts can be established. It is common practice to log temperature differentials across bearings and coolers. When differential at coolers departs from established norm, deposits may be accumulating on either oil or water side of cooler.

It is also common practice to take frequent samples of oil for visual inspection for water, emulsions or suspended matter. Laboratory tests upon periodic samples will indicate any significant change in the oil that might lead to accumulation of deposits. Frequent inspections of oil sump drain, and of oil purifying equipment, will also help indicate rate of deposit accumulation.

Any unusual conditions (increase in rate of deposit removal by the oil purifying equipment, departure from normal oil pressure at any point in the system, presence of water in the oil, change in temperature differential, change in oil tests), will warn of some abnormal condition in the system. Through inspection, source of difficulty must be determined and deposits removed. It is, of course, desirable to eliminate causes as soon as possible, to hold formation of deposits to a minimum and avoid necessity for extensive cleaning of the lubricating system.

How Must You Clean System?

Inspection may show deposits ranging from viscous oil film to solids completely choking oil passages. Method of cleaning will depend, of course, on amount and nature of insoluble material. Laboratory examination of representative sample of deposit will assist in determining best means of removal. Only experience will serve as a guide to evaluation of conditions.

Final decision on means of removing insoluble material should be reached only after consultation with all concerned, including turbine manufacturer and oil supplier.

How to Clean Oil Coolers (Stationary and Marine)

Marked change in oil temperature differential across cooler, with no change in water flow or temperature, may indicate excessive build-up of deposits on oil or water side or both. On larger units, twin coolers are usually installed so that one can be removed from service for cleaning without interruption of turbine operation. Where cooler tube bundle can be removed from the system, cleaning methods may be employed which would not be considered practical for the turbine lubricating system proper. Hot water or steam washing, or petroleum flushing oil are usually employed for cleaning oil side of coolers.

If other cleaning agents are employed, note that, regardless of the materials used, all traces of the cleaner should be thoroughly removed to prevent subsequent oil contamination. The cleaner employed should not attack finish of tubes; such attack may lead to formation of metallic soaps, which can stabilize oil-water emulsions. In addition, cases have been reported where cleaners have activated cooler tube surfaces, making them extremely effective catalysts for turbine oil oxidation. After cleaning, hydrostatic tests should be made on coolers to check for leaks.

Oil Systems of Stationary Units †

Following methods have been used with success for the cleaning of stationary units of varying sizes. Method selected depends largely on laboratory examination of deposit and cleaning materials, facilities and time available. When appreciable quantities of deposit are present and accessible, the bulk of it should, of course, be removed manually.

Steam and Hot Water Cleaning (Stationary Units)

Tarry matter from oil-degradation products and oil-water emulsions can often be removed from turbine parts by steam or hot water washing. Care must be taken not to blow steam or hot water into bearings or governor mechanisms, which are usually cleaned manually, Steam is preferable to hot water, due to possibility of scalding.

When using hot water, boiler feedwater at about 180 F is usually employed, blown through the piping at high velocity. If piping can be dismantled, this may be done to insure more thorough cleaning. Bearing pedestals and oil reservoirs are cleaned by directing a stream of hot water against surfaces of the parts. Clean dry air should be used immediately after the hot water, to dry the parts.

Steam at high velocity has been used with good success under a variety of conditions. Flexible steam hose is used, the end covered with a cap tapped for insertion of a short

*ASME Paper No. 50-A-116

†Detailed instructions for preparing turbine oil system for initial use after installation, proper use of oil conditioning equipment, recommended ASTM tests for oil characteristics, how to get right oil and keep it right and operating items to watch, were all given in a series of articles on Oil Systems for Industrial Steam Turbines by Frank C. Linn, Turbine Divisions, General Electric Co., *Power Generation*, (now POWER ENGINEERING) April, May, June, August 1949. The diagram is reproduced from one of these articles.

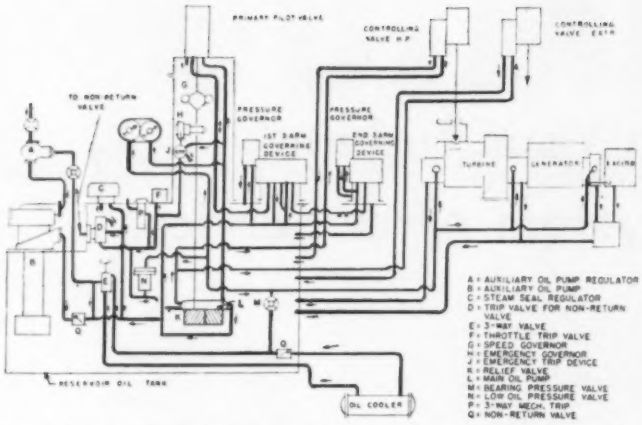


Diagram of complete oil system for turbine, generator and exciter of a double-automatic-extraction industrial steam-turbine generator†

nipple with an opening approximately ¼ in. in diameter. Pedestals, reservoirs and pipe are steamed out and dried with clean, dry compressed air.

Since steam or hot water washing will remove protective oily films from metal surfaces, making them prone to rusting, the lubricating system should be protected as quickly as possible with a rust-inhibited turbine or flushing oil. Governor parts should be dipped in the rust-inhibited oil immediately after cleaning and the unit should be assembled and a rust-inhibited turbine or flushing oil circulated through it as soon as possible.

Cleaning with Flushing Oil (Stationary Units)

The oiling system should be arranged for maximum oil flow and velocity during cleaning. Exact steps depend entirely on turbine construction. In some instances, maximum flow is secured by removing upper halves of bearings and any external orifices, if used; or by rolling lower halves of bearings about the shaft far enough to uncover oil supply passages. Bearing pedestal covers are then replaced to prevent unnecessary oil leakage. In other cases, maximum oil flow is easily obtained by removing internal connection pieces between oil supply line and each bearing. Connection pieces in bearing housings are accessible by removing inspection opening covers placed there for that purpose.

Charging the Flushing Oil

Sufficient charge for flushing (50–75 per cent normal oil charge) of rust-inhibited turbine or flushing oil is then placed in the turbine. The oil is heated in any convenient manner to between 150 and 180 F, and maintained at this temperature while being circulated by the turbine auxiliary oil pump for from 4 to 24 hr or more, depending on size of turbine, or nature and amount of deposits. Oil may be heated by passing hot water through water section of cooler or by installing a temporary low-pressure (5 lb max.) steam coil in oil reservoir. Venting devices and continuous by-pass oil purifiers, available as part of the oiling system, should remain in operation during entire flushing period.

Oil piping, passages, and parts in the governing system that come in contact with oil, need to be cleaned. This should be done without danger of scoring working parts of governing mechanisms. During flushing, pilot valves can be removed and the pistons either removed or blocked in open position.

In some instances, high-pressure oil passages to governor and other control mechanisms are blanked off during early stages of flushing so as to have relatively clean oil for flushing the governor system. Toward the end of the flushing period, blanks should be removed so flushing oil can clean oil piping and passages of governing system.

After flushing, governor parts, passages and the like should be manually cleaned with lintless cloths.

How Long to Flush

Required duration of flushing may be judged from periodic check of strainers and other oil purifying equipment. When successive inspections reveal no noticeable increase in deposits, it is reasonably certain that all contaminants have been removed from system. Clean lintless cloth bags are often placed inside the strainers, their appearance during flushing giving a ready check on progress of cleaning.

As soon as flushing is completed, the oil should be drained from tanks, coolers, and oil purifying equipment while it is still hot, but venting should continue until system returns to approximately room temperature. This will assure more complete drainage, as well as removal of any impurities that may be oil-soluble at flushing temperatures, and will minimize condensation that could cause rusting. All low spots that could serve as traps must be drained and accessible parts of the lubrication system inspected as thoroughly as possible, any remaining deposits being removed manually with lint-free cloths.

Bearings and piping may then be returned to their original locations, and assembly of turbine completed. Turbine is then charged with a supply of clean lubricating oil of grade to be used for regular operation, and given customary operational checks accorded every unit before it is placed in regular service. At conclusion of this step, many operators make final investigation of cleanliness of oiling system. When conditions permit, oil may be temporarily removed from the system so it can be thoroughly inspected. If this is impossible, or inadvisable, at least the strainers and oil purifying equipment should be checked for excessive or unusual deposits.

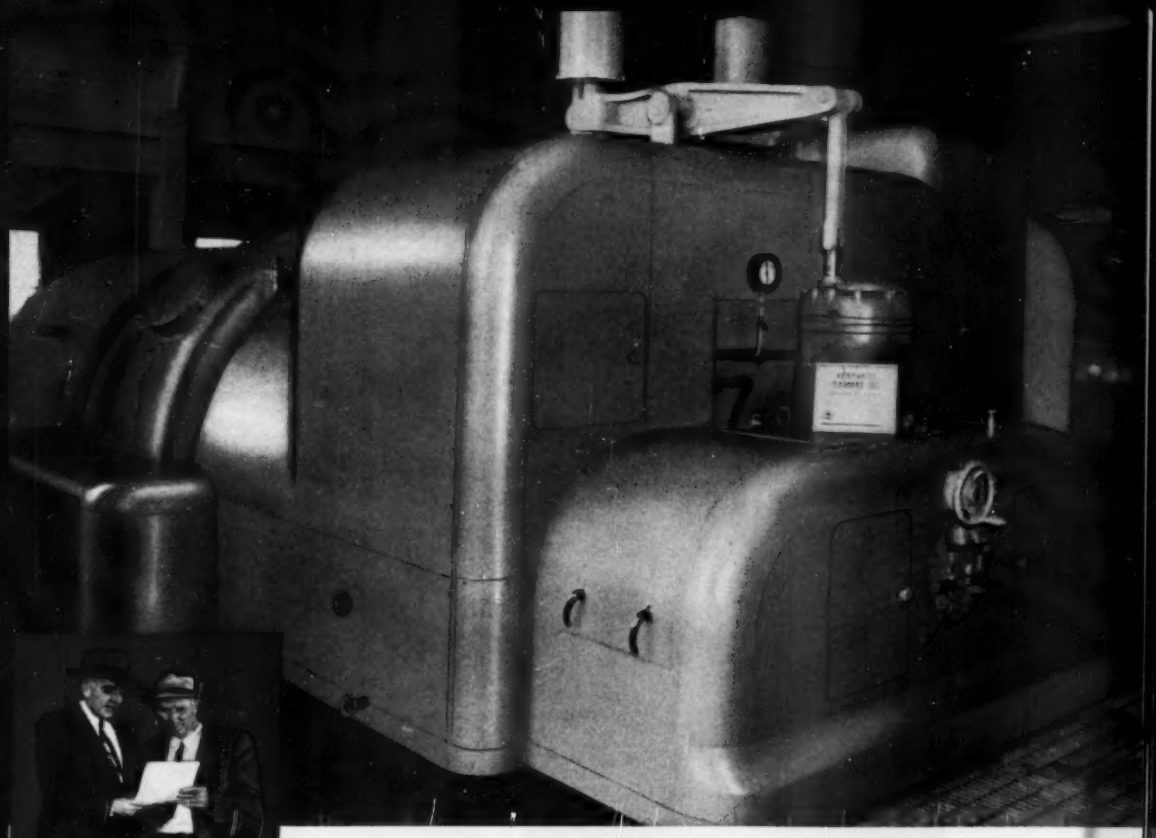
Cleaning During Service (Stationary Units)

In some instances, where a lightly-sludged unit cannot be taken out of service long enough for thorough cleaning prior to an oil change, continuous by-pass circulation of the oil in the system, through a clay filter, has been used to remove solids and partially-soluble oil degradation products. Of course, passing an inhibited oil through clay will remove the inhibitors, hence the oil supplier should be consulted before doing it.

Because the unit is in operation when this is done, governor operation and bearing temperatures should be watched carefully, since solid particles may be loosened that would be large enough to restrict oil flow and interfere with operation.

Cleaning Marine Propulsion Units

It is not practical to use the same methods in cleaning dirty marine units that can be employed for stationary units because of the more extensive piping and the presence of gear sets with their lubricating devices, which make the marine oil system more complicated than those of stationary units. Inaccessibility of oil piping in marine units makes it impractical to clean by flushing with hot water or steam. Complex oiling systems of marine units may permit greater buildup of deposits in inaccessible locations. For such systems, deposits can be most effectively removed by consecutive flushings with a rust-inhibited flushing oil, followed by turbine oil of the grade recommended for regular operation. Procedure used in a number of cases was detailed in the paper.



One (good) thing leads to another

at Coffeyville, Kansas

Al Manis, superintendent of the Coffeyville municipal power plant, and Standard Oil (Indiana) lubrication specialist Thomas R. Smith, review the latest report on NONPAREIL Turbine Oil in service in the 10,000-KW turbine above. The neutralization number: 0.04 mg. KOH/gm.

Low acidity was one of the advantages Coffeyville engineers counted on in specifying NONPAREIL when this turbine was installed in June, 1949. NONPAREIL already had shown its resistance to deterioration, its freedom from deposits, and its elimination of acidity troubles, in the municipality's 5,000-KW turbine where it has been in service since 1945. The performance record on this first unit . . . a record including no oil replacement, no necessity to remove the oil for treatment, no downtime for cleaning of the oil system . . . was reason enough for insisting on NONPAREIL in the second turbine.

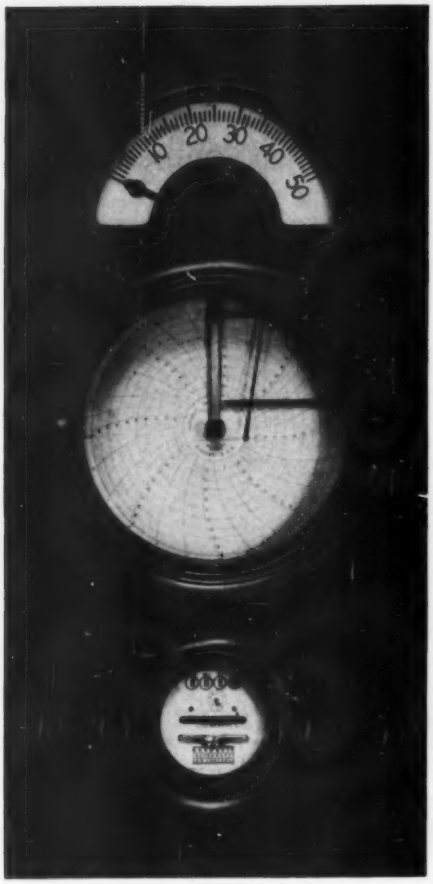
Consider what a similar lubrication performance record can mean to your own operating and maintenance costs. Consider too, that NONPAREIL Turbine Oil is guaranteed in writing to last as long as your turbine. Its neutralization number is guaranteed never to exceed 0.15 mg. KOH/gm.

For details on NONPAREIL Turbine Oil as applied to *your* turbine installation, and case studies showing the results of up to 23 years continuous trouble-free operation of NONPAREIL in other installations, call for the services of your Standard Oil lubrication specialist. You can reach him at your local Standard Oil Company (Indiana) office, or write: Standard Oil Company (Ind.), 910 S. Michigan Ave., Chicago 80, Ill.

NONPAREIL
TRADE MARK
Turbine Oil

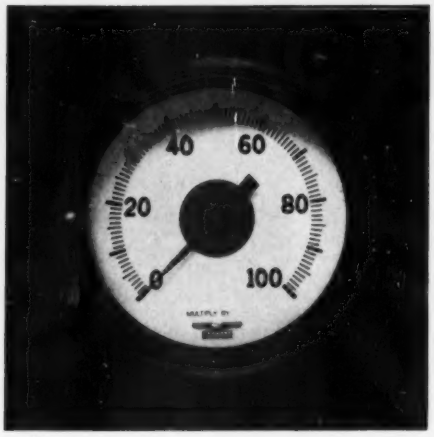
STANDARD OIL COMPANY (INDIANA)

STANDARD



Indicator-Recorder-Integrator

Varying flows because the



Indicator

The Republic flow integrator, being of the modified watt-hour type, totalizes continuously —not intermittently. It operates independently of the recorder and its accuracy is not dependent on or affected by any clock mechanism or mechanical action.

The Republic meter is, on this account, peculiarly fitted to follow all changes in flow rate and accurately measure highly fluctuating flows.

ALL TYPES OF FLUIDS

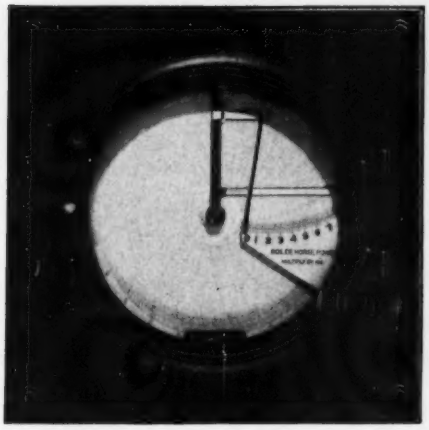
Republic electric type flow meters are available for measuring the flow of all types of liquids and gases. Meter bodies are built for metering fluids at line pressures up to 5,000 lb. per sq. in. and for all ranges of differential pressure. The reading instruments — indicator, recorder and integrator—are of the remote reading type and can be located any distance from the point of flow measurement.

ANY COMBINATION

While each Republic reading instrument is standard in design and construction each is especially calibrated for the particular flow measurement for which it is specified. Any reading instrument, indicator, recorder or integrator, may be obtained separately or in any

are accurately totalized

integrator is continuous



Recorder

Integrator

combination desired, making possible the highest degree of flexibility in plant use.

SIMPLE IN OPERATION

The Republic electric meter is the only flow meter commercially manufactured which is strictly electric in its operation. All other types of so called electric meters use the motion of the mercury to move a float or produce a force which is then converted into an electrical value which is in turn transmitted to a receiving or reading instrument. In the Republic meter, the transmitted electrical value is determined directly by the mercury motion, thus eliminating one of the steps in the sequence, and simplifying the mechanism to that extent. Their are no floats, levers, cams, rotating shafts or anything else to interfere with the unimpeded movement of the mercury, which has no work to perform, but merely fulfills the function of making contact.

NEW DATA BOOK

Just off the press—a completely new data book describing and illustrating, in detail, the operating features of the Republic Flow Meter and its many applications. Write for your copy of Data Book No. 702—there is no obligation.

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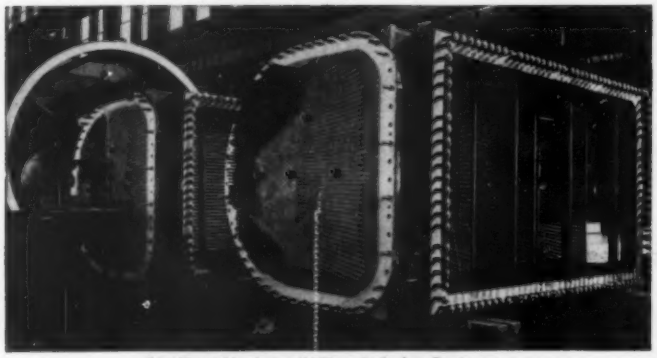
BRIDGEPORT BRASS COMPANY
CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

"Bridgeport" MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Installing tubing in two 7,500 sq. ft. Surface Condensers.
Courtesy Allis-Chalmers Manufacturing Co.

90-10 Cupro Nickel Condenser and Heat Exchanger Tubing

During the present emergency many users of 70-30 and 80-20 cupro nickel tubing will be faced with the problem of selecting suitable substitutes for these excellent alloys. This is in keeping with the defense program which calls for conservation of nickel for military needs.

Fortunately, for the past few years much work has been done in determining the relative merits of cupro nickel alloys with lower nickel contents. The most promising is 90-10 cupro nickel containing 1% to 1.75% iron. This alloy shows good corrosion resistance in flowing sea water, the iron acting as a corrosion inhibitor. It compares very favorably with 70-30 cupro nickel containing 0.5% iron.

Applications Growing

Appreciable quantities of 90-10 cupro nickel have already replaced Admiralty condenser tubes in surface condensers of power plants using salt water for cooling purposes. Results to date have been very encouraging.

Where 90-10 cupro nickel has been tried out in oil refineries, it has shown superiority over Admiralty from the circulating salt water side although it is not as satisfactory as Admiralty when in contact with hydrogen sulphide and similar components. Admiralty has been the standard alloy for oil refineries for many years, but there has been a move towards changing to more impingement resisting alloys especially among refineries located on the seaboard. Aluminum brass, Duronze IV (aluminum bronze), and 70-30 cupro nickel are now quite common for handling corrosive harbor waters.

In beet sugar evaporators 90-10 cupro nickel has also proven superior to brass, Admiralty, and aluminum brass on the vapor side, which is quite corrosive.

Offsetting Impingement Corrosion

Like the higher-nickel content alloy, 90-10 cupro nickel shows fine resistance to impingement corrosion which is one of the enemies of condenser tube life. Impingement corrosion thins the metal especially at the entrance end of the tubing for a distance of possibly six or eight inches. Sometimes the attack extends throughout the tubes or is localized anywhere along the length of the tube.

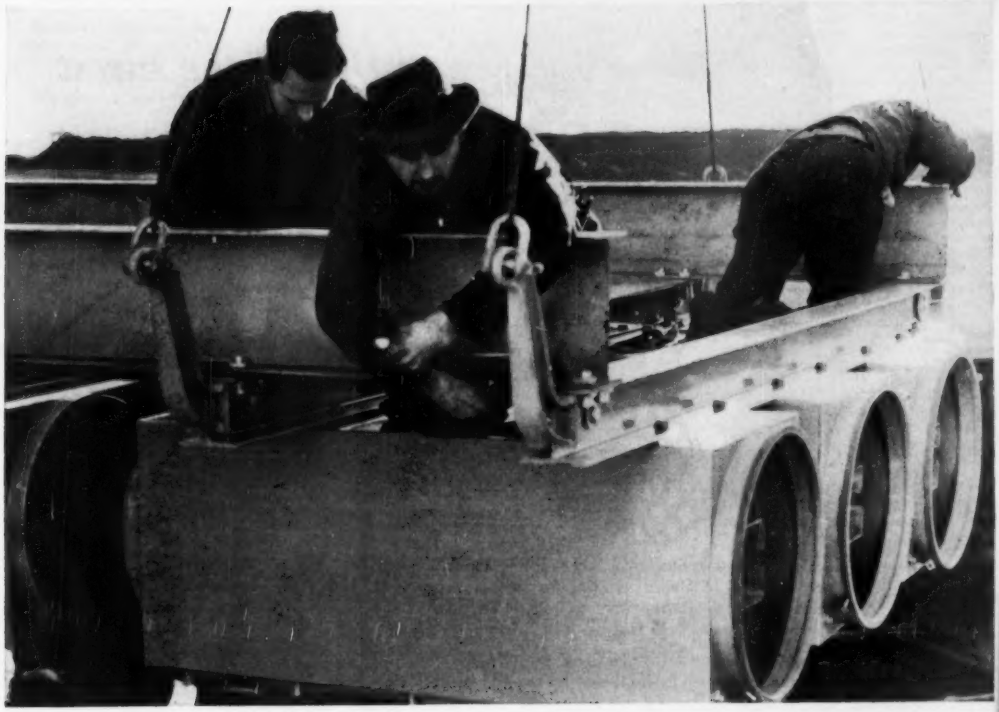
The brunt of the impingement attack is at the mouth of the tubing where it receives the full impact of the circulating water. Sea water is a more active solvent than fresh water. The higher the water speed, the more severe the attack.

Effect of Velocity

Some alloys are more sensitive to impingement attack than others. Admiralty brass, which stands up nicely against circulating sea water at low velocities such as four feet per second, may fail rapidly when the water velocity is raised to seven feet per second and higher. The practice of using higher water velocities explains why there is a trend away from Admiralty, which does not stand up well under such conditions. Aluminum brass withstands impingement corrosion better than Admiralty and all of the cupro nickel alloys are also far superior to Admiralty against this type of attack.

In the interest of conservation of materials as well as the investment itself, it pays to give close attention to the selection of the alloys which will give the longest service life and minimum shut-down time. As time goes on, the experience gained from accumulated records of condenser tube behavior pays big dividends. We appreciate the cooperation of operating engineers which has enabled our Corrosion Laboratory to help with corrosion problems. (7113)

Remove crate . . . Lift into place

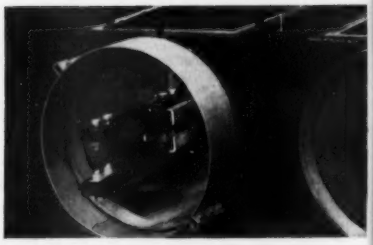


ISOLATED-PHASE BUS SECTIONS shipped assembled, ready to install

Factory-assembled G-E isolated-phase bus sections pay off in low installation costs. Crated three-phase sections arrive ready to lift into place. You simply knock sides off crate—apply lifting brackets to "H" mounting beams and hoist into position for permanent bolting. When bus connections are made with semi-flexible connectors and sectional joints are sealed with gasketed banding rings—the job is complete!

Other advantages of G-E design include high insulation values—reduced number of creepage surfaces without sacrifice of mechanical strength—dust and water-tight hinged covers which open from either side for easy inspection.

Your G-E sales representative has complete information. Ask him for a copy of GEA-5460, a 28-page publication that will aid you in planning your buses, or write to General Electric, Schenectady 5, N.Y.



Semi-flexible connectors join copper buses of adjacent sections. This provides quick and easy alignment between sections. Split gasketed aluminum banding rings seal out dust and water, reduce maintenance.

855-29

GENERAL ELECTRIC

"One of the surest ways to make money is to save money..."

CAPTAIN EDDIE RICKENBACKER

President and General Manager
Eastern Air Lines, Inc.

"... and the purchase of U. S. Savings Bonds through the Payroll Savings Plan is an easy way to save. It is good for the community. It is good for you because it means money available for a rainy day. Through the thousands of years that men have roamed the globe there have always been rainy days."

A vigorous exponent of thrift, Captain Eddie Rickenbacker made the Payroll Savings Plan available to his employees of Eastern Air Lines some years ago. From time to time, in personally dictated letters addressed "To All Members of Eastern Air Lines Family", he points out the individual and national advantages of the Payroll Savings Plan, and urges members of Eastern Air Lines Family "... to sign up on the Automatic Payroll Savings Plan. In years to come I am sure you will be mighty glad you did."

How about *your* Payroll Savings Plan? What have you done since Savings Bonds became Defense Bonds? What is your percentage of employee participation?

From coast to coast, companies large and small are installing the Payroll Savings Plan or revitalizing their present plans through person-to-person canvasses which put a Payroll Savings Application Blank in the hands of every employee.

Note the results of some recent person-to-person canvasses. Think what management efforts like this mean to the Defense effort. Then phone, wire or write to Savings Bond Division, U. S. Treasury Department, Suite 700 Washington Building, Washington, D. C. Your State Director will be glad to help you put in a Payroll Plan or show you how to conduct a person-to-person canvass.

Results of recent person-to-person canvasses to increase participation in Payroll Savings

39 companies ... total employees	487,347*
Employees on plan before canvass	81,481
Employees on plan after canvass	329,942
% of participation before canvass	16.8%
% of participation after canvass	67.7%
New savers added to plan	**248,461**

Based on National averages, employees in this group of companies are saving more than $7,000,000 every month in United States *Defense* Bonds.

**Includes 62,070 employees of six companies which did not have plan before canvass.*

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Reports of Various Subcommittees of the Prime Movers Committee, Edison Electric Institute, 420 Lexington Avenue, New York 17, N. Y.

Metallurgy and Piping 1950. Report of the Metallurgy and Piping Subcommittee; EEI Publication No. 50–10; 8½ by 11 in.; paper binding; 42 pages; illustrated; Price — Members — 90 cents, Non-Members USA — $2.25; Foreign countries — $2.50.

This report contains statements relating to metallurgy and piping by the subcommittee, Operating Companies and Manufacturers on activities of various piping organization, high temperature materials, high temperature pipe welding and fabrication specifications, graphitization, valve outages and miscellaneous data.

Deposits on Gas Side of Steam Generating Units. Report by the Power Station Chemistry Subcommittee; EEI Publication No. 50–13; 8½ by 11 in.; paper binding; 10 pages; illustrated; Price — Members — 30 cents; Non-Members USA — 75 cents; Foreign countries — 90 cents.

This report contains statements of operating companies on their experiences with deposits on the gas side of steam generating units, and general discussion, summary and conclusions based on the literature and member company experiences.

Since this report was written, much additional work has been reported on this subject. In particular, the effects of humidifying combustion air in minimizing gas side deposits have been reported in ASME Paper No. 50-A-86 by Murphy, Piper and Schmansky of The Detroit Edison Co. and have aroused wide-spread interest among power engineers. Also, a review of recent German practice is given in *Brennstoff-Warme-Kraft*, June, 1951.

Final Report of the Investigation and Development of Facsimile Recording Paper, by Office of Technical Services, 15 pages, Order from Library of Congress, Photo duplication Service, Publication Board Project, Washington 25, D. C., accompanied by check or money order payable to the Librarian of Congress. Price $1.75 per copy in microfilm, $2.50 in photostat.

A number of promising developments in facsimile recording papers are discussed in this report, now available to the public.

Primary purpose of the study, made by the Timefax Corp. under Signal Corps contract, was to survey possible methods of making direct daylight facsimile recording papers, preferably of the dry recording type. In the course of the work, one new paper was developed and two papers were improved to the point of becoming commercially practical. Papers discussed include the Mimeograph Stencil, Non-Duplicating Recording Paper, Timefax Duplicating Paper and Pressure and Heat-Sensitive Paper.

Detailed tables are presented covering the properties of some colloidal carbons, (electrical conductivity, pH, carbon content and particle size); the resistance of base and intermediate coatings; a partial list of pigments and binders examined for base and intermediate coating combinations; and a partial list of pigments and related substances used in top coatings.

The report concludes with suggestions for further development in the field, and a supplementary list of facsimile recording paper and related patents.

Influence of Polyphase Motors on The Voltage Regulation of Circuits Supplying Single-Phase Welder Loads. University of Illinois, Engineering Experiment Station, Bulletin Series No. 392. Written by M. A. Faucett, Professor of Electrical Engineering, M. Fisher Jr. Special Research Assistant in Electrical Engineering, and M. S. Helm, Associate Professor of Electrical Engineering. Price, $1.00. Paper bound, size 6 by 9 in. 80 pp.

The bulletin is divided into two parts. The first part presents analytical solutions of the voltage change produced by a single-phase welder, including the effects of adjacent motor loads. The second part contains charts which may be used to determine voltage drop for some of the more commonly used welder circuits. A complete set of instructions for using these charts is also included. The charts offer a practical and time saving method of determining the voltage drop when a large number of problems involving single-phase welders and various amounts of motor load are to be considered.

Review of Current Research and Directory of Member Institutions. Published by the Engineering College Research Council of the American Society for Engineering Education, at the Georgia Institute of Technology, Atlanta, Georgia. Edited by John I. Mattill, Secretary, at the Massachusetts Institute of Technology, Cambridge, Massachusetts. Copies, at $2.25 each, may be obtained from the Secretary of the Engineering College Research Council, Room 7–204, 77 Massachusetts Avenue, Cambridge 39, Mass. Size 6 by 9 inches, paper bound, 250 pages.

This volume is a review of engineering research projects which are now active in the engineering schools of American colleges and universities. In addition to complete research project titles, the book shows for each school the names of responsible research administrative officers, a brief digest of policies which govern research projects and contracts at each institution, the number of personnel engaged in research activities, the annual expenditures, and special conferences and short courses of interest to research workers. The listings given of projects and personnel are complete as of March 1, 1951. A complete index of research project subjects, including over 4000 entries, facilitates use of the book.

Basic Electrical Measurements by Melville B. Stout; first edition; 504 pages; 6 by 8½ in.; cloth; published by Prentice-Hall, Inc., 70 Fifth Ave., New York, N. Y.; 1950.

As pointed out in the preface, the author of this book finds the selection of material for a book on electrical measurements rather difficult. Measurements play so vital a part in electrical science and the field of measurements and instruments is so vast that no single book could ever hope to present a comprehensive treatment of the field as a whole. The field of measurements includes activities ranging all the way from the absolute determination of the units to the simplest kind of everyday measurements, and students must be thoroughly prepared for this broad field but not in a way too exclusively pointed towards any one portion of it. Some understanding should be given of basic high precision methods but not to the exclusion of less precise but more commonly used methods. An attempt has been made, therefore, in this book, to select the methods that are most important and most frequently used in present-day practice and to omit special procedures and those now mainly of historical interest. Some of the older ways of measuring resistance, for example, have been dropped. Also, d-c bridge methods for the determination of inductance and capacitance. Alternating current bridges have been stressed as versatile and accurate means of performing many types of measurements. The author realized that no two persons would agree completely on the choice of material but it was felt essential to clearness and usability to limit the scope of the treatment.

Since this book is designed primarily as an undergraduate text, problems are introduced throughout the text as an important part of the study of measuring processes. The treatment of electrical measurements has tended to present equipment and circuits in a descriptive way, in spite of the fact that the subject itself is highly quantitative. The author feels that problems are at least as important in this subject as in other studies in which they are regularly used.

The author is Professor of Electrical Engineering at the University of Michigan and this book is evidently the result of many years of teaching experience in this field. On the whole, this is a very interesting and valuable book and should be of interest to practicing engineers as well as to undergraduate students in engineering colleges.

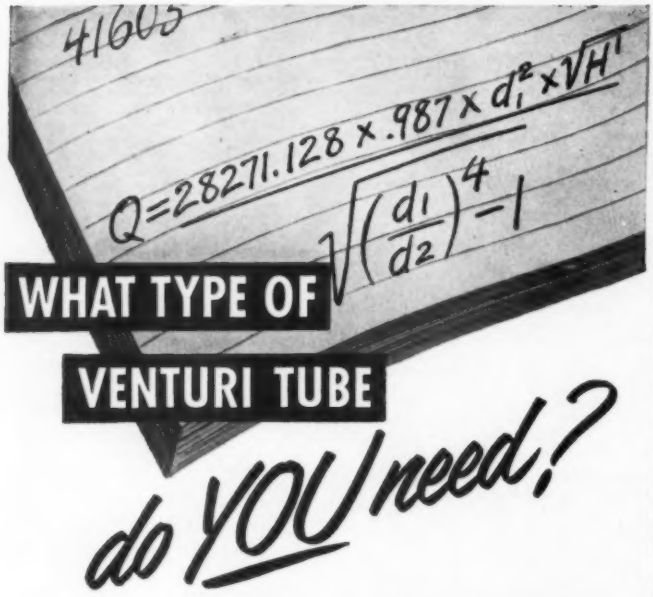
Thermodynamics by George A. Hawkins; Second Edition; 563 pages; size 5½ by 8½ in.; clothbinding; published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $6.50.

This is a textbook for use in a two-semester undergraduate course of three credit hours per semester. For the student who wishes to make a more extensive study in a particular subject, the author includes a list of references at the end of each chapter. The material has been arranged so that by leaving out certain chapters the book can be used as a one-semester text. Chapters such as *Combustion, The Gas Turbine and Jet Propulsion, General Thermodynamic Equations* and *Introduction to Heat Transfer* can be omitted from the first semester agenda and then picked up in the later course along with some of the more advanced theory.

Professor Hawkins makes his first mention of the entropy concept almost halfway through the book. He uses the Carnot engine as an introduction to entropy and then devotes an entire chapter to a discussion of energy and entropy. His treatment of this subject — one which is a universal stumbling block for engineering students — is unusually lucid.

Theoretical presentations are supplemented by the addition of simple practical problems which show the reader the usefulness of the subject in engineering work. The problems in the text and the exercises and questions at the end of each chapter are of value to the practicing engineer as they contain many examples of problems he encounters in his daily work. Although there are some explanations of theoretical material which delve into the calculus, the major portion of the book requires no knowledge of advanced mathematics. An effort is also made to show that the subject of thermodynamics is not limited to engineering but is applicable to other branches of science as well.

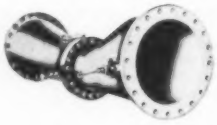
Six chapters have been completely rewritten from the first edition and significant changes have been made in another five. A new table, dealing with the thermodynamic properties of air, has been added to the second edition Appendix.



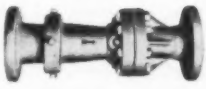
WHAT TYPE OF VENTURI TUBE do YOU need?

1. Steel plate tube with cast iron throat section for measurement of clear water, air or gases.

2. Cast iron Venturi Tube with hand holes and cleaning valves at main and throat sections, for municipal sewage and trade wastes.



3. Cast iron Venturi Tube with flat invert and single cleaning valve at main and throat sections. Specifically used for sludge.



4. Cast steel or cast iron Venturi for hot or cold water and adaptable for boiler feed high pressure service.

IT'S SIMPLEX IT'S ACCURATE

SIMPLEX makes Venturi Tubes for measuring cold water, raw sewage, trade waste, sludge, process liquor, boiler feed, air and gases.

These tubes come in many sizes and different designs, some of which are pictured above. This means there's a particular tube to fit specific needs.

Write, stating your Venturi Tube requirements, to Simplex Valve & Meter Company, Dept. 8, 6783 Upland Street, Philadelphia 42, Pa.

SIMPLEX

VALVE AND METER COMPANY

PALERMO

(Continued from page 98)

and a 220-v station auxiliary bus. The 3000-v bus derives its power directly from the generator through the 5000-kva, 10,500/3000-v transformer. The 220-v bus in turn derives its power from the 3000-v bus through the 1150-kva, 3000/240-v transformer. These two unit buses serve all the auxiliaries for their generator units.

In addition to the normal auxillary supply there is a 5000-kva, 10,500/3000-v reserve transformer which is connected directly to a breaker on the 10,500-v switchgear. This transformer is connected to the reserve 3000-v bus. This reserve bus supplies power to the station essential auxiliaries such as coal handling, ash handling, fire pumps, etc. In addition, this bus provides standby and starting-up power to each 3000-v unit auxiliary bus and serves the 1150-kva, 3000/240-v reserve transformer. This reserve transformer, in turn, supplies 220-v power to the station essential auxiliaries and standby power for each 220-v unit bus.

All of the auxiliaries of this plant are electrical with the exception of the one boiler feed pump turbine drive. The larger essential motors, 100 hp and above, are 3000 v and each is connected to an individual electrically operated air circuit breaker on the 3000 v bus. All other motors ½ hp to 100 hp are 220 v. The larger of these 220-v motors are connected to individual electrically operated air circuit breakers on the 220 v bus. The smaller 220 v motors are served from the 220 v bus in groups, each group making up a motor control center. Each group has a single manually operated circuit breaker and each individual motor has a combination magnetic starter and circuit breaker. The grouping of these motors is so arranged that operation of the plant is not disturbed by the removal of any one group from service.

TRANSFORMERS—The two unit and the one reserve 3000-v station service transformers are located on the ground floor, below the electrical switchgear. Each transformer is 5000 kva, three phase, 10,500/3000 v, delta/delta and non-inflammable liquid filled. The transformers are provided with two 2½ per cent rated kva taps above and below 10,500 v, with a manual no-load tap changer.

The three 220-v station service transformers are also located on the ground floor. These transformers are rated 1150-kva, 3 phase, 3000/240-v, delta/delta, non-inflammable liquid filled, with two 2½ per cent rated kva taps above and below 3000 v. A manual no-load tap changer, with operation from floor level is provided.

RELAY PROTECTION—The generator is protected by high speed product restraint differential relays. For back up protection voltage restraint overcurrent relays, which trip only on a

high current and low voltage, are used.

The 3000-v station service transformers and the station service reserve transformer are protected from faults by harmonic current restraint percentage differential relays. The two types of restraint present in these relays prevents tripping on magnetizing inrush current and heavy through currents.

The 10.5-kv bus is protected by high speed differential relays which operate in from two to three cycles. Each 10.5-kv feeder is protected against phase to phase and three phase faults by directional overcurrent relays, and against phase to ground faults by directional overcurrent ground relays.

The 3000-v motors are protected by long time induction over-current relays with instantaneous trips. The induction element is set so the time curve of the relay falls below the motor damage curve for values of current in excess of 115 per cent of the motor full load current. The instantaneous trip is set just above locked rotor current. For backup protection of the 3000-v bus, induction overcurrent relays are used. The 220-v station service transformers are protected by standard inverse time delay, induction overcurrent relays with instantaneous trips.

BATTERY SYSTEM—The control voltage for this station is 125 v, direct current. A 60-cell storage battery, rated 564 amp for one minute down to 1.75 v per cell and a 12-hr discharge rate of 43.2 amp, is installed in a battery room on the ground floor. Two 3-kw motor generator sets are provided for charging the battery; one floats on the battery at all times and the other is used as a standby. This battery supplies control power for the entire station.

COMMUNICATION—For intercommunication within the station, an automatic dial type telephone system is provided. There are 15 telephone stations located at essential points throughout the station. Head booths are provided where the noise level is high. Horns are provided at each station. The phone system operates on 24 v, d-c. The horns are operated by 125 v, d-c by use of a 24-v relay.

STATION LIGHTING—The station lighting system operates at 220 v and is supplied from a breaker on the reserve 220-v switchgear. In case of failure of the normal lighting source, emergency lights, which are located at all essential parts of the plant are automatically switched on.

In general, the plant lighting consists of incandescent industrial type dome fixtures giving an average illumination of 10 to 15 foot-candles. The turbine room is illuminated by high bay incandescent fixtures. The intensity of illumination in the turbine room is 25 foot-candles. The mechanical and electrical control rooms are illuminated by fluorescent strip lights placed above a luminous ceiling.

A QUICK ECONOMICAL way to clean small tubes

ROTOJET ® Junior Tube Cleaners offer advantages possessed by no other type. They are light in weight, fed easily with the hose, and shifted quickly from tube to tube.

The ROTOJET Motor is unusually powerful and efficient. It has only two moving parts, a shaft and a paddle. Positive contact, maintained between paddle and Rotocentric (egg-shape) bore cylinder, assures an undivided air stream and freedom from power loss. An air valve permits one-man operation. Models for straight and curved tubes .495" I.D. up. Water-driven models for tubes .953" I.D. up.

ROTOJET size, speed, and ease of operation offer a marked contrast with external cleaners costing many times as much. Send for new bulletin.

Roto Heads are economical

Roto Heads meet practically every cleaning need. Expanding brushes and scrapers have inexpensive replaceable elements for economical operation.

Expanding brush, ball joint, replaceable brush element.

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Fig. 4001/6561. Duplex unit consisting of Straightway Lever-operated Sealing Valve and Angle Blowing Valve.

BOILER BLOW-OFF VALVES

When you install an EVERLASTING Duplex Blow-Off Unit, you'll find that its many superiorities speak for themselves.

The sealing valve at the left is the EVERLASTING design that has been famous for more than 40 years . . . the valve with the drop-tight seal that actually improves with use because of its self-lapping action each time the valve is opened or closed . . . the valve that can't stick or jam because of its non-wedge design . . . the valve that opens in less than a quarter turn to provide unimpeded straight-through blow.

The blowing valve at the right is the equally famous EVERLASTING Angle or "Y" Valve, specially designed and equipped to withstand repeated blow-off shocks, erosion and corrosion, and without pockets that might trap and hold solids.

Each of these valves . . . and all the other EVERLASTING Boiler Blow-Off Valve types, fully meet ASME code requirements . . . assurance that they are properly designed and amply strong for the service.

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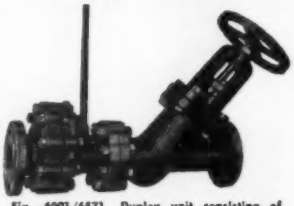

Fig. 4001/6571. Duplex unit consisting of Straightway Lever-operated Sealing Valve and Y Blowing Valve.

Fig. 6571/6561. Duplex unit consisting of Y Sealing Valve and Angle Blowing Valve.

Fig. 6561/6571. Duplex unit consisting of Angle Sealing Valve and Y Blowing Valve.

Everlasting Valves

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EV-340

FOR EVERLASTING PROTECTION

LETTERS TO THE EDITORS

(*Continued from page 63*)

in the boiler. Inside these tubes the vapor condenses quickly into pure distilled water."

The following should be of interest to steam engineers: ". . . it is noteworthy that one of the factors which helps maintain the partial vacuum is that the water vapor, or steam, occupies an extremely small volume of space."

Steam at 65 deg. has a volume of 1,024 cu. ft. per lb. So for each unit of 3,500,000 gpd capacity, the vapor output would be 20,200 ppm, or 20,700,000 cu. ft. per min. The "fan" to handle this vapor would be SOME FAN! A duct to handle this vapor, assuming an extreme velocity of 10,000 fpm, would be more than 51 ft. in diameter! The power to operate this fan probably wasn't given any more consideration than any of the other factors.

The problem of condensing the vapor was given a bare mention in the article, but which problem would be a tremendous one! The water for condensing the vapor must, of course, be at a lower temperature than the vapor. Where this water was to come from wasn't mentioned; it probably being considered of minor importance. The only source of water in sufficient quantity is the ocean, and its temperature was assumed as 65 deg. But condensing 65 deg. steam with 65 deg. water doesn't seem hopeful.

Assume that there is another source of sea-water that will give a 10-deg. differential, or at a temperature of 55 deg. Also that it weighs 8.55 ppg, and its specific heat is 0.94 Btu. The heat of evaporation of steam at 65 deg. is 1,055 Btu per lb. The heat absorbed by the condensing water is then $20,200 \times 1,055 = 21,300,000$ Btu per min. With a 3-deg. approach of water to vapor, there would be required $21,300,000/(10 - 3) \times 8.55 \times 0.94 = 378,000$ gpm or 545,000,000 gpd. The handling of such a quantity of water would be a major problem in a very large city!

With a 3-deg. approach of condensing water to vapor, the mtd would be nearly 5.83 deg. And if an overall coefficient of 500 Btu were obtained, the condenser surface would be $21,300,000 \times 60/5.83 \times 500 = 439,000$ sq. ft. If this were of 1-in. tubing there would be 318 miles of it.

It was stated that, "The steam ultimately passes into open-ended condensation tubes placed in the boiler." That may mean that the vapor is to be condensed by the incoming feed but, as stated in the foregoing, this would imply condensing 65 deg. vapor with 65 deg. water. Anyway, the required condenser surface as found above, would fill many shells the size of the boiler.

In order to have continuous operation of the boiler, there must be provided a continuous supply of water of the required temperature. Any

heat given up by the water lowers its temperature, and there is produced a circulation, but a feeble one, because of the probable small temperature drop. For the sake of this discussion, however, we shall assume a 5-deg. drop. Since the heat required to evaporate a pound of water at 65 deg. is 1,055 Btu, the water that must be supplied to the boiler is 21,300,000 /5 × 0.94 × 8.55 = 530,000 gpm or 763,000,000 gpd. Quite a pumping job for what was described in the article as ". . . one ordinary water pump."

There have been opinions, expressed and implied, that the engineering profession has been negligent in coping with imminent water shortages, with an ocean at our door. But the only at present practical method of converting sea-water to general use is by means of heat. And though this is being done in many instances — for cooking, drinking, boiler makeup and the like — its application to a common municipal supply of 100 gpd and more per capita, is far too costly. Hence the doors are open to the many varieties of quacks who haven't even a nodding acquaintance with the problem.

Had the promoters of the present scheme figured the magnitude of any of its functions, they might save themselves and others some embarrassment. But they evidently did not possess the required knowledge.

Calculating the heat load is a simple matter, and it could be compared with the performance of other and similar equipment. For example: There was to be produced 3,500,000 gpd, or 3,500,000 × 8.33/24 = 1,210,000 lb. of distillate per hour. The heat of evaporation of water of 65 deg. is 1,055 Btu per lb. The heat load is then 1,210,000 × 1,055 = 1,278,000,000 Btu per hr. This is the equivalent of 1,278,000,000/970.3 × 34.5 = 38,200 boiler horsepower. Even a greenhorn should be startled by this figure!

It would seem that before any one puts money (his own money) into any scheme for converting sea-water to domestic use, he should employ a sophomore in engineering to put him straight.

C. O. SANDSTROM
Los Angeles 4, Calif.

KULJIAN SCHOLARSHIPS

TO HELP engineers meet problems of human relations that are often encountered in their work, particularly in foreign countries, Harry A. Kuljian, noted Philadelphia engineer and head of the engineering firm bearing his name, has established two scholarships for seniors at the Massachusetts Institute of Technology. Mr. Kuljian was graduated from M.I.T. in 1919.

These scholarships are intended to help promising engineering students to round out their education in world affairs, traditions, economics, and

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the humanities. The scholarships, valued at $500 each, are to be awarded to two seniors whose records indicate exceptional promise.

The creation of the new School of Humanities and Social Studies at M.I.T. encouraged Mr. Kuljian to establish these scholarships, and at his request candidates for them are to be nominated by Dean Burchard of the new school. The purpose of the scholarships is to assist the winners to broaden their education in the field of the humanities and social studies, in order that they may gain a better understanding of human relations in applying their technical training.

HELPFUL BULLETINS

(*Continued from page 46*)

brochure. Tells how company's electrical tape combats corrosive action of moisture, alkalies, oils, fats and fungi on underground gas service pipes. Features report of a gas company citing tape's exceptional corrosion protection, speed of application, good conformability with extra stretch and other advantages. Also includes photos showing application techniques, and listings of tape's chemical, physical and electrical properties. Minnesota Mining and Mfg. Co.

TOOLS

128 Powerful Puller — Introduced in 8-pp Bulletin 97-A is the compact Power Twin, a fast-working hydraulic ram designed to take the hard work out of pulling jobs. Explains how this ram, with its center hole feature, is adaptable to all of company's pulling systems, converting them to hydraulic push, pull or lift operation. Shows time-saving methods for installing and removing cylinder sleeves, snafts, gears. Also shows conversion sets. Owatonna Tool Co.

129 Installation and Maintenance Tools — Sixteen-pp Bulletin 451 is company's recently published ordering book covering installation and maintenance tools. Presents air motors for tube rolling, buffing and polishing tools, calipers, ratchet wrenches, jigs, plug pullers, boring bars, rethreading tools, and gaskets. A section on tube expanders illustrates major types, gives their applications, dimensions, prices; includes a tube expansion chart. Key Co.

TURBINES

130 Multi-Stage Turbines — Six-pp Bulletin S-147 describes two of company's smaller-frame multi-stage turbines, both of the impulse type. Construction details are illustrated and described in detail, dimensions included. The Terry Steam Turbine Co.

131 Equipment for Power Plants — Liberally illustrated Bulletin Q-14 is a 20-pp booklet reviewing manufacturer's complete line and describing briefly the major steam and electrical products of company's five plants. Material is organized into sections, one on steam and related equipment (turbines, centrifugal blowers, condensers, heaters, tube cleaners) and the other on rotating electrical equipment (motors, generators, motor-generator sets). Elliott Co.

STOKERS, ACCESSORIES

133 Stoker Feeder Conveyor — This 2-pp bulletin describes and illustrates a 16-ft slow-speed stoker feeder conveyor for boiler room use. Explains how it's designed to operate economically, save labor and handle a variety of fuels safely. American Coal Burner Co., Inc.

134 For Cleaner Coal Burning — This 8-pp illustrated bulletin describes company's Turbo-Aire over-fire systems designed for cleaner coal burning. Explains how they work to eliminate smoke and promote efficient combustion. Includes selection chart, specifications, fan data and characteristics. Canton Stoker Corp.

OIL HEATING

135 Oil Heaters — Three new products are presented in 16-pp Bulletin O-51: an oil pre-heater which heats oil indirectly by gas and operates independently of boiler; a safety oil heater so constructed that oil cannot enter the boiler water if an oil heating tube fails, and company's Type-U-Tube oil heater recommended where a low cost installation is specified. Also shown are straight-tube and suction heaters. Applications for each type of heater discussed; dimensions and capacities are given. Water Tube Boiler and Tank Co., Inc.

136 Data on Oil Burning — "Oil Burning Manual of Information" is a 4-pp guide to proper installation and operation of oil burning equipment. Filled with tables and formulas covering air flow through airports, available draft, excess air, boiler pressure and flue gas temperature, air volume capacities. Compiled in the interest of increasing oil burning efficiency this bulletin is instructive and saves a lot of calculation. Cleveland Fuel Equipment Co.

OTHER EQUIPMENT

137 How to Cut Waste Costs — A factual treatise, "Four Ways to Economize on Industrial Wastes," discusses briefly main types of industrial wastes and special problems involved in their handling. Explains ways of coping with waste costs by reduction of waste volume, by improved

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High grade gas, by-product, steam and household stoker coal from Wise County, Virginia, on the Interstate Railroad.

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processing methods, by conversion of wastes to by-products and by treatment. Gilbert Associates, Inc.

138 Booklet on Transmission Belting — Here's an informative 16-pp booklet on treaded leather belting which includes practical maintenance suggestions and engineering data. Well illustrated, contains information on making belts endless on pulleys, types of motor bases, fasteners, lacings, cement, preservatives, and repairing belts. Helpful belt formulas are included, along with a table on horsepower rating of shafting of various diameters at various speeds. Company's patented tread feature and special mineral tannage are explained, pictured. Specific applications are illustrated. E. F. Houghton & Co.

139 Weed Control Manual — Data on methods and results in chemical brush and weed control, as practiced by a wide range of organizations, are outlined in this 12-pp operations manual. Includes records of brush control experience of telephone companies, power companies, a soil conservation experiment station etc. In each case, methods of chemical control of undesirable growth which have been most satisfactory are presented along with cost data and evaluations of short-term versus long-range control programs. E. I. du Pont de Nemours & Co., Inc.

140 How Safe Are Your Drawings? — Four-pp Handbook SC 688 indicates multiple dangers to engineering drawings under defense conditions, showing the kind of fire-resistant protection such drawings should have. Facts illustrating inadequacy of fireproof building construction in protecting drawings are given. Cabinets, files and map and plan units are described, illustrated. Remington Rand Inc.

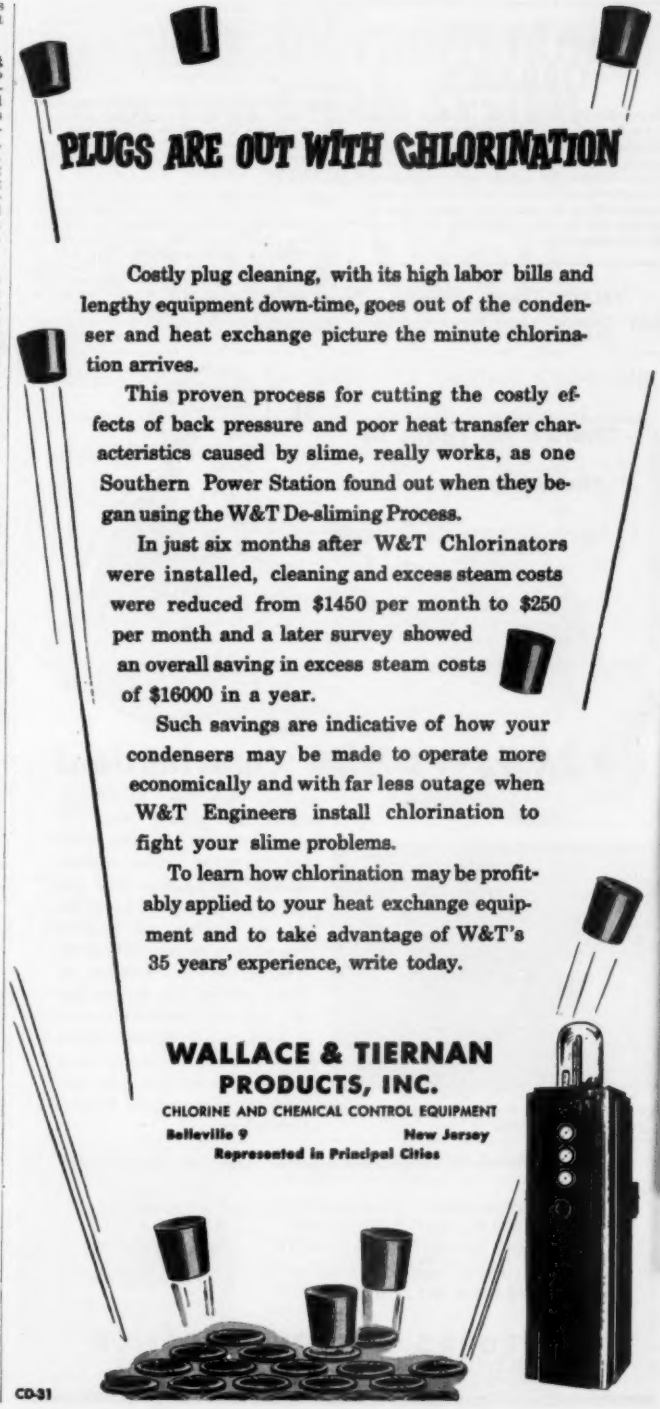
141 Refractories and Insulations — Here's a comprehensive collection of data on company's refractory and insulating materials. It shows when and how to use the various types of materials in industrial, heat processing and heat generating equipment of all kinds. Refractories covered include castable cements, chrome base castable cements, air- and heat-setting bonding cements, and ramming-type refractories. Insulating materials include block and blanket types, plastic heat insulations, electrical insulations and surface protective coatings. About 38 pp in all, sheets are loose-leaf bound. Refractory and Insulation Corp.

142 Jacket Water Coolers — Illustrated Catalog 1351, 4 pp, describes a line of engine jacket water coolers described as extremely rugged units capable of withstanding abuse of portable equipment installations. Details the many new design features of the new units and describes accessories available as optional equipment. Young Radiator Co.

143 JIC Pneumatic Standards — The Joint Industry Conference's recently adapted standards on pneumatics are offered to power engineers in a 12-pp illustrated booklet. In it the "Standards" are reproduced in full, with sample circuit, glossary of terms, standard symbols, also a comparison showing how company's air cylinders meet the JIC Standards. Booklet is hole-punched for standard ring binders. Miller Motor Co.

144 Civil Defense Communications — Twelve-pp Form G93-122 pictorially presents typical communications now in use which can be coordinated into a dependable emergency communications network in any community. Also describes company's technical advisory service for civil defense radio communications, listing representatives in 22 district offices who are available to analyze existing systems and recommend methods of forming them into a single network to operate in any emergency. Electronics dept., General Electric Co.

145 Mobile Ladders — This 6-pp illustrated bulletin stresses safety advantages of all-steel mobile ladders of one to eight steps, also a new four-step ladder with adjustable push bar hangers for use with stock carts. Ballymore Co.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VALVES, TRAPS, PIPING

201 **General Service Valves** — Bulletin E-160, 16 pp, describes and illustrates design and construction of company's quick-operating valves, explaining their application to blow-off service and on chemical process, soot blower, water column blow-down, and other types of pipe line. Includes dimensions, weights; prices. Everlasting Valve Co.

202 **Unions and Fittings** — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special construction features and other advantages. E. M. Dart Mfg. Co.

203 **Blow-Off Valves** — Illustrated Bulletin B-433, 24 pp, describes blow-off valves for high-pressure boilers, and covers seatless, hard-seat and unit-tandem types, for working steam pressures from 400 to 2500 lb. Construction details and operating principles are illustrated. Dimensions and specifications included. Yarnall-Waring Co.

204 **Popular Steel Valves** — Condensed Catalog 104, 28 pp, describes and illustrates most widely used of company's cast and forged steel valves and the data presented for these valves is complete. Those listed are chiefly in the basic steam pressure classes — 150 to 2500 lb — and include globe and angle, gage, instrument, hydraulic and relief types, also strainers, and check, gate, non-return and blow-off valves. Explains design features, gives construction details, ratings, specifications. Edward Valves, Inc.

205 **Valves, Fittings and Flanges** — Catalog F-9 is a 400-pp. permanently bound reference book on drop forged steel valves, fittings and flanges for practically all piping needs at high and low pressures and temperatures. Provides not only ordering information on company's complete line, but also much helpful engineering and application data, and includes a section on products for refrigeration service. Fully illustrated, well-indexed. Available to qualified power engineers, please give your title. Henry Vogt Machine Co.

206 **Piping Pointers** — This is a new 36-pp edition of company's highly popular piping manual covering fundamentals of sound piping practices. Discusses various types of valve designs and how each should be used. Pictures and names more than 80 fittings and contains many illustrated how-to-do-it features. Included with manual is an 8-pp valve selection guide. Crane Co.

207 **Valve Specialties** — Included in 90-pp Catalog A-50 is complete ordering and engineering information on automatic pressure flow and liquid level controls for steam, air, gas, water, oil, other fluids. Sections are devoted to pressure regulators, altitude valve, pump governors and strainers; lever, float and motor operated valves, pilot valves; back pressure, relief and non-return valves, steam trap and air vent; liquid level controllers; solenoid valves. Includes capacity charts. Davis Regulator Co.

208 **Pressure Reducing Valves** — Selection and engineering data on pressure reducing valves, including those for remote control of reduced steam or water pressures, are presented in 12-pp Bulletin 477-A. Northern Equipment Co.

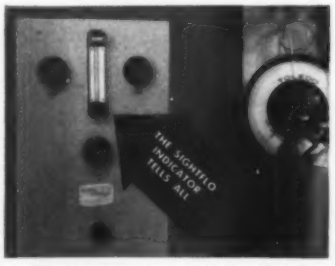
209 **Steam Traps and Temperature Controls** — Here is a comprehensive catalog comprising many of company's bulletins on steam traps and related equipment, including an illustrated steam trap selection chart. Provides data on boiler steam traps, air eliminators, thermostatic steam traps and air vents, inverted bucket steam traps, temperature regulators and cooling controls, steam and water mixers, thermostats and strainers. Sarco Co., Inc.

210 **Steam, Air, Gasoline Traps** — This 32-pp illustrated catalog, No. 250, describes five types of thermostatic steam traps for pressures to 225 lb; expansion steam traps for pressures to 250 lb; weight-operated traps for steam, air and gasoline service, pressures to 1500 lb; piston-operated steam traps for pressures to 650 lb, and also steam, air and gas separators. Includes capacity tables. W. H. Nicholson & Co.

211 **Handbook on Fittings and Flanges** Catalog wf-1950, 88 pp, is packed with working information on seamless carbon steel welding fittings and forged steel flanges. In addition to presenting standard schedules with their specifications, list prices and sizes, book gives information on dimensional tolerances; American standard flange facings with dimensions; thread standards and threading practice; service pressure ratings, physical and chemical requirements for flanges, nuts and bolts; plus sizes and wall thicknesses of welding fittings in other metals. Grinnell Co., Inc.

212 **How to Choose and Use Air Traps** — Bulletin 202, 4 pp, describes a line line of air traps, covering their selection and installation for automatic drainage of moisture from compressed air intercoolers, aftercoolers, receivers, separators, drip points. Prices included. Armstrong Machine Works.

213 **Safety Valve Engineering Data** — How company's safety valve works and its important operating advantages are



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BUILDERS PROVIDENCE Instruments

explained in Bulletin 707, 4 pp. Includes dimensions on flanged and welded inlet valve types, tables on superheat correction factor, capacities. Manning, Maxwell & Moore, Inc.

214 High Pressure Gate Valve — Described in 4-pp Form DH-273 is a forged steel gate valve designed for long service and low cost maintenance. Working pressures, sizes and prices listed. R-P & C Valve Div., American Chain & Cable Co., Inc.

215 Design Properties of Pipe — This new 12-pp booklet consists of tables listing pipe sizes and wall thicknesses currently established as standard, plus what is believed to be a most complete tabulation of dimensional properties of commercially available sizes of steel pipe. Tube Turns, Inc.

216 Strainers and Separators — Bulletin R-46-50A is a 16-pp catalog on T-type strainers, suction strainers, multiflow and receiver separators. Contains dimensions, weights, prices. Shows how several types have been redesigned for increased efficiency. Dimensions, service pressure ratings. American District Steam Co.

ELECTRICAL

217 The Why of Dry Type Transformers — Booklet B-4428, 24 pp, discusses reasons why dry-type transformers are safer and less expensive to install and maintain in industrial plants and utilities. Types of air-cooled transformers for every use are illustrated from small ones for operation of intercommunication systems to power centers as large as 10,000 kva. Also describes sealed, submersible, dry-type transformers. Westinghouse Electric Corp.

218 Power Factor Correction — Examples showing basic considerations in the improvement of system power factor are contained in Bulletin O5B7465, 4 pp. Points out economical and operational advantages of improving plant power factor and advisability of keeping the load power factor up to 0.8 lagging or higher; tells how the effects of low power factor can be corrected. Allis-Chalmers Mfg. Co.

219 Synchronous Motors — High speed synchronous motors are described in 4-pp bulletin PB 5600-1. The bulletin is packed with descriptive matter and photographs explaining features. Elliott Co.

220 Care of A-C Rotating Equipment — To promote intelligent and consistent maintenance of electrical machines, company has published Bulletin O5R7417, which is a series of articles by Fraser Jeffrey. Contents of the 24-pp booklet cover preventive maintenance and machine repairs, and such subjects as drying moist insulation, measuring insulation resistance. Allis-Chalmers Mfg. Co.

221 Buyers' Manual on Motors and Control — Fifty-pp Catalog GEC-1009 presents buying information on a carefully selected group of motors, motor starters, control accessories and electronic control. Ratings listed are those most frequently required. Excellent data on proper selection is provided as well as dimensions, ratings, prices. Illustrated. General Electric Co.

PUMPS AND COMPRESSORS

222 Compressor Selection Chart — Here's a chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor, giving quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Worthington Pump and Machinery Corp.

223 Boiler Feed Pumps — Bulletin 109, 16 pp, illustrated in color, describes detail centrifugal pumps for boiler feed service. Explains and pictures construction and major parts, explaining in detail the floating seal incorporated. Capacity data is provided, vapor pressure tables. Pacific Pumps, Inc.

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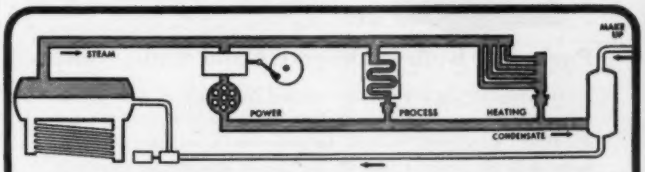

The CORAVOL ZONE—indicated by the shaded area in the diagram—includes every part of a steam system not accessible to boiler feed water treatment. It includes the boiler above the water line, steam lines, condensate return lines, radiators, valves, traps and equipment. This zone can now be reached and protected against rust and corrosive action—by CORAVOL.

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224 **Pulsation-Free Compressor Piping** — Illustrated Bulletin PDS-8501, 4 pp, describes company's pulsation dampening piping system. Tells how this piping compares in first cost to other piping, but affords higher operating efficiency, other advantages. Explains pulsation phenomena in gas compression systems and how dampening principle is applied. The Fluor Corp., Ltd.

225 **Data on Pumps — All Types** — Bulletins are available on centrifugal, reciprocating, screw and rotary pumps covering a wide range of capacities and services. Includes information on single and multistage, close coupled, single and duplex piston, and special pumps for handling erosive and corrosive liquids, also high viscosity liquids, both lubricating, non-lubricating. Warren Steam Pump Co., Inc.

BOILERS AND AUXILIARIES

226 **Re-Circulation Steam Generator** — Here's a 6-pp folder introducing a controlled re-circulation steam generator, describing its development and recommended uses, such as applications where steam is required in remote locations, where demands are intermittent or load fluctuating. Illustrated, text explains operation, features. Combustion Engineering-Superheater, Inc.

227 **Packaged Generators** — Bulletin SB-38 introduces company's new Keystone model. Photos and sketches show complete unit, pressure element and details of its compact design. Gives advantages of two-drum water boiler, three-pass gas travel, automatic gas or oil burner. Dimensions, capacities. Erie City Iron Works.

228 **Shop-Assembled Boiler** — Eight-pp Bulletin G-72 introduces company's new integral furnace boiler. Describes and illustrates its economy, ease of installation and connection, flexibility, minimum space requirements, efficient combustion, fast steaming. The Babcock and Wilcox Co.

229 **Dowtherm Vaporizer** — Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer, tells how this unit is designed to evaporate Dowtherm so as to provide dependable operation at maximum temperatures. The Wickes Boiler Co.

230 **Tube Expanders** — Bulletin 380, 8 pp, covers manufacturer's line of tube expanders for maintenance of high pressure boiler tubes, superheaters, economizers, circulating tubes, steam generators, other equipment. Thomas C. Wilson, Inc.

231 **Rotary Tube Cleaners** — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads, discussing special features. Also includes data on motors, hose. Roto Div., Elliott Co.

232 **Streamlined Baffle Walls** — Bulletin BW-44, 20 pp, describes company's baffle walls, showing their application to modern boilers and for modernising existing units. Fully illustrated with photos and drawings covering installations, remodeling designs. The Engineer Co.

233 **Air Preheaters** — Illustrated Bulletin A-11610, 8 pp, defines air preheat and explains its benefits in terms of increased efficiency and capacity and flame stability. Provides general description of company's preheater, discusses its application to boiler plants. The Air Preheater Corp.

234 **Soot Blower Head** — Illustrated Bulletin 485, 4 pp, describes a new rotary soot blower head for improved boiler cleaning. Explains how blower head is designed to give maximum blowing pressure through the full blowing arc, is rugged, easily serviced, economical. Vulcan Soot Blower Div., Continental Foundry & Machine Co.

INSTRUMENTS AND CONTROLS

235 **For Centralized Control** — Bulletin 109, 4 pp, presents the new, compact Mini-Line equipment suited to contro

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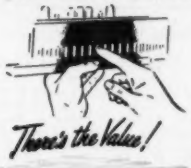

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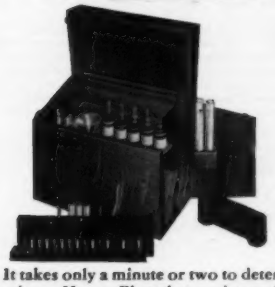

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board arrangement which concentrates vital operating information and controls for one or more boilers, turbines or process units before a single operator. Describes and illustrates vertical-scale indicator units, selector valve, remote manual relay. Bailey Meter Company.

236 Remote Reading Flow Meters — Data Book 702, 32 pp, fully illustrates and explains flow measurement problems and offers suggestions for their solution. Meter bodies, differential devices and reading instruments are fully described. Republic Flow Meters Co.

237 Flow Meters — Bulletin 400-F2, 8 pp, features company's meter for measurement of steam, air, or gas flow in 1 or 1¼ in. pipe lines, and designed for installation directly in the line being metered. Illustrated with photos of meter, sectional and dimensional drawings, bulletin discusses meter's advantages. Builders-Providence, Inc.

238 Putting the Ratio Totalizer to Work — Twelve suggested applications of company's ratio totalizer in automatic control circuits are described and illustrated by diagram in 8-pp Bulletin 5450. This new device is a pneumatically operated control mechanism for combining input control pressures and spring forces to produce a single output control pressure. Hagan Corp.

239 For Practical Men — That's the title of this 24-pp pocket-size booklet presenting insulation testing in simple language. Packed with maintenance hints, it explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in terms of long run economy and avoiding shutdowns. James G. Biddle Co.

240 Air Locks — Bulletin 8-31, 2 pp, describing company's air locks and trip master controls for holding regulating and control valves in position during failure of air supply, is illustrated with photos, diagrams and line drawings. The Swartwout Co.

241 Flow Tubes — Catalog 80, 4 pp, presents engineering data on a new primary element for measuring, regulating and controlling fluid flow. Tells how these flow tubes are designed and how they function. Foster Engineering Co.

242 Control Equipment — General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes in detail: venturi tubes and meters, controllers, gages, manometers, pilot equipment. Simplex Valve and Meter Co.

WATER CONDITIONING

244 Water Conditioning Information — Here are three informational bulletins of value to power engineers. No. 28X7446 describes a simple and accurate way to determine total hardness in water, illustrating procedure and explaining principle. No. 28X7559 gives an analysis of the hot process-hot zeolite system, telling results to be expected and advantages. No. 28X7466 discusses current status of embrittlement in boilers, explaining causes and telling recent developments in control methods. List bulletins wanted. Allis-Chalmers Mfg. Co.

245 Modern pH and Chlorine Control — This 100-pp booklet gives technical details of company's color comparators and equipment in water testing and control of boiler and industrial process water, also technical information on the meaning of pH control, electrometric and colorimetric methods of determining pH and also determining impurities in water; applications of water control in air conditioning; treating boiler feed water. W. A. Taylor & Co.

246 Water Softeners — Bulletin WC-102 is a 36-pp presentation of recent developments in hot-process water softeners.

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Explains boiler plant troubles caused by various impurities in water, outlines 12 methods of treating water to eliminate these impurities, describes reasons for the popularity of the hot-process method and its advantages, explains chemistry of hot-process water softening. Graver Water Conditioning Co.

247 One-Minute Water Tests — Rapid, simple and accurate tests for determining water hardness are described in Bulletin 1RE50, 4 pp. Procedures, reagents, and equipment are pictured and described. Bulletin tells how tests may be used to determine water hardness, hardness due to calcium alone and hardness due to magnesium alone. Hall Laboratories, Inc.

248 Boiler Water Treatment — Bulletin 47, 8 pp, is on internal treatment of boiler water. Defines internal treatment and tells its advantages in softening, sludge conditioning, stabilization. Explains operation of company's system, including the chemicals used. National Aluminate Corp.

249 Ion Exchange Systems — "Amberlite Monobed Deionization" is a 12-pp miniature textbook covering the history, behavior, present performance, and potential uses of the Monobed ion exchange systems in water-conditioning, chemical processing and other industries. Reactions of various combinations of exchangers are explained in text and equations. Also discussed are operating costs, equipment costs, quality of product derived, rinse requirements. The Resinous Products Div., Rohm & Haas Co.

250 Pocket Book on Chemicals — Here's a handy little 28-pp manual covering chemical products used by the power engineer. Most of those listed are water treating chemicals, but there's also a brine treatment, a fuel oil sludge dispersant, a soot remover, and protective coating. Tells what each product does and how and where to use it. Includes a helpful application chart. Western Chemical Co.

251 Boiler Water Manual — Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-pp technical bulletin, called Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater system, condensate returns, flushing. %Proportioneers, Inc.%

252 Water Softening Equipment — How the problems caused by hard water can be offset by the use of water softeners is explained in Bulletin 2386, 12 pp, describing ion exchange equipment. It covers in detail downflow, upflow and gravity zeolite water softeners. Illustrates a fully automatic softener. The Permutit Co.

253 Water Treatment — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations to suit individual plant requirements. Covers pretreatment, internal treatment, treatment application, blowdown adjustment and test control. Filled with illustrations, also describes available equipment and includes a reference bibliography of literature on specific formulations. Dearborn Chemical Co.

254 Boiler Corrosion — A 12-pp article discussing the cause and prevention of corrosion in boiler systems is presented in Bets Technical Paper No. 111 titled "Corrosion: Its Effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity, physical factors evaluated. W. H. & L. D. Bets.

255 Zeolite Water Softeners — Publication 4530, 16 pp, presents hydrogen zeolite (cation exchange) water softening equipment. Gives complete description of the process and the field of application, showing advantage of hydrogen zeolite softening and its relation to sodium zeolite softening process. Bulletin not only provides an exhaustive explanation of the new process but of the zeolites themselves. Cochrane Corp.

256 Corrosion Treatment — "Corrosion Protection of Steam and Condensate Return Systems" is a 4-pp folder covering amine treatment for inhibiting of boiler and condensate systems. This treatment is described as affording surface protection of the metal itself as well as raising the pH value of the condensate. The Bird-Archer Co.

257 Slurry Type Softener — Six-pp Bulletin W-212-B6 describes a slurry type precipitating softener and coagulator in which energy for floc preparation is mechanical, explaining and illustrating flow circuit. An excellent question-and-answer appraisal of system is included, equipment pictured. Worthington Pump and Machinery Corp.

258 Organics in Water Treatment — Here's an interesting 4-pp folder describing the need for organics in altering the nature of sludge in order to make it nonadherent. Covers theoretical and practical considerations involved in use of organics; describes manner in which they overcome problems of sludge. Power Chemicals Div., E. F. Drew & Co., Inc.

FUEL OILS, LUBRICANTS

259 Fuel Oil Treatment — By text and sketches, this folder points out undesirable conditions in the storing, pumping, heating and burning of industrial fuel oil and the correction of these conditions by company's fuel oil treatment. E. F. Drew & Co., Inc.

260 Grease Application Devices — The development and use of many types of lubricating devices are discussed in an excellent article in Vol. 36, No. 9 of Lubrication, company's technical publication on lubricants. Covers the pressure gun, spring type grease cups and several types of power driven

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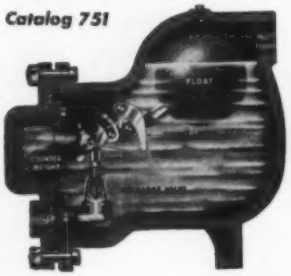

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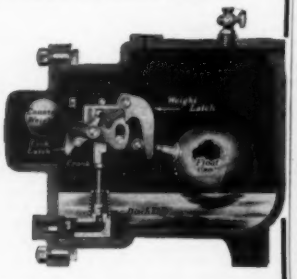

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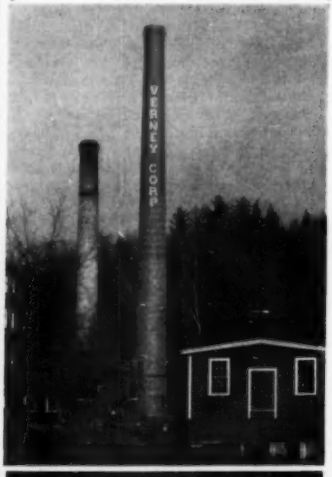

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261 Air Compressor Lubrication Manual — Valuable information on air compressor maintenance is contained in this 40-pp illustrated book. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, and safety precautions. Cities Service Oil Co.

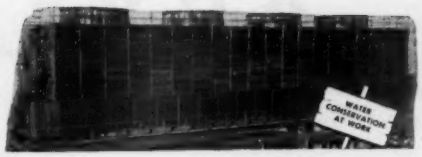
262 Diesels, Their Fuels and Lubricants — This 46-pp book offers a well organized and attractive presentation of practical information on diesel engines, covering their history and economics as well as their design characteristics and operating principles. Classification of diesels according to speed is explained. Other chapters cover injection systems, combustion chambers, lubricating systems, and diesel oil purification and filtration. Includes a discussion of fuel and lubricating oil required. Sinclair Refining Co.

CONDENSERS

263 Steam Condensers with Reserve Flow — Eight-pp Catalog 410-1 describes a "self-cleaning" reverse-flow condenser for power plant service, designed to virtually eliminate cleaning down time and, in the case of divided water box condensers, eliminate operation at partial load. C. H. Wheeler Mfg. Co.

264 Ejector Instruction Manual — Bulletin J-50-7 is a 36-pp handbook covering operation, selection, installation and maintenance of steam jet air ejectors. Discusses twin and triple element ejectors, surface and jet inter- and after-condensers, isolating valves, drain traps, steam and back pressures, steam nozzles, condensing water,

(*Continued on page 134*)



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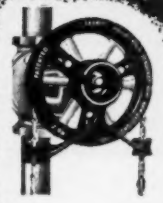

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Agency — Ellington & Company, Inc.
Cleaver-Brooks Company 15
Agency — Klau-Van Pieterson-Dunlap Associates, Inc.
Cochrane Corporation 16–17
Agency — Willard G. Myers Advertising Agency
Combustion Engineering-Superheater, Inc. 12–13
Agency — G. M. Basford Company
Condenser Service & Engineering Co., Inc. 51
Coppus Engineering Corporation . . . . . *
Agency — James Thomas Chirurg Company
Crane Co. 53
Agency — The Buchen Company
Crane Packing Co. . . . . *
Agency — Symonds, MacKenzie & Co., Inc.
Darling Valve & Mfg. Co. 50
Agency — Griswold-Eshleman Co.
Dart Union Co. 123
Agency — Sutherland-Abbott
Davis Engineering Corporation . . . . . *
Agency — Thomas & Delehanty, Inc.
Davis Regulator Co. . . . . *
Agency — Armstrong Advertising Agency
Dearborn Chemical Company 59
Agency — The Buchen Company
De Laval Separator Co., The 9
Agency — Donahue & Coe, Inc.
Detroit Stoker Company 25
Agency — Witte & Burden
Dowell Incorporated 47
Agency — MacManus, John & Adams, Inc.
Drew & Co., Inc., E. F. 39
Agency — The Aitkin-Kynett Co.
Eastern Gas and Fuel Associates 37
Agency — Ketchum, MacLeod & Grove, Inc.
Edward Valves, Inc. . . . . *
Agency — Marsteller, Gebhardt & Reed, Inc.
Elliott Co. 2–3
Agency — Peterson & Kempner, Inc.
Ellison Draft Gage Co. . . . . *
Agency — Tri-State Advertising Co., Inc.
Engineer Co., The 31
Agency — Michel-Cather, Inc.
Erie City Iron Works . . . . . *
Agency — Davis and McKinney
Everlasting Valve Co. 122
Agency — Michel-Cather, Inc.
Flexitallic Gasket Company 55
Agency — William Jenkins Advertising
Fluor Corporation, Ltd. . . . . *
Agency — Dozier, Eastman & Co.
Foster Engineering Company 103
Agency — Sanger-Funnell, Incorporated
Foster Wheeler Corp. . . . . *
Agency — Albert Frank-Guenther Law, Inc.
Garlock Packing Co., The . . . . . *
Agency — Hutchins Advertising Company, Inc.
General Coal Company 124
Agency — The Aitkin-Kynett Co.
General Electric Company 117
Agency — G. M. Basford Company
Gifford-Wood Co. . . . . *
Agency — O. S. Tyson and Company, Inc.
Gilbert Associates, Inc. 21
Agency — The Richard A. Foley Adv. Agency, Inc.
Goodall Rubber Co., Inc. . . . . *
Agency — George C. Taylor
Graver Water Conditioning Co. . . . . *
Agency — Michel-Cather, Inc.
Green Fuel Economizer Co., Inc. 128
Agency — Sanger-Funnell, Incorporated
Grinnell Co., Inc. . . . . *
Agency — Horton-Noyes Company
Griscom-Russell Co., The 38
Agency — Michel-Cather, Inc.
Hagan Corporation 43, 49
Agency — Ketchum, MacLeod & Grove, Inc.
Hall Laboratories, Inc. . . . . *
Agency — Ketchum, MacLeod & Grove, Inc.
Hays Corporation, The 40–41
Agency — Proebsting, Taylor, Inc.
Infilco Incorporated 26
Agency — The Vanden Company, Inc.
International Nickel Company, Inc., The 36
Agency — Marschalk & Pratt Co.
Johns-Manville 129
Agency — J. Walter Thompson Company
Kuljian Corporation, The . . . . . *
Agency — Al Paul Lefton Company, Inc.
Ladish Co. . . . . *
Agency — The Cramer-Krasselt Co.
Manning, Maxwell & Moore, Inc. . . . . *
Agency — Fuller & Smith & Ross, Inc.
Marley Company, Inc., The 14
Agency — Valentine-Radford Advertising
Mundet Cork Corporation . . . . . *
Agency — J. C. Bull Incorporated
National Airoil Burner Company, Inc. 133
Agency — R. E. Lovekin Corp.
National Aluminate Corporation 44
Agency — Armstrong Advertising Agency
National Valve & Mfg. Co. . . . . *
Niagara Blower Company . . . . . *
Agency — The Moss-Chase Company
Nicholson & Co., W. H. 130
Agency — Wilbur A. Myers
Northern Equipment Company 18
Agency — Davies and McKinney
Norton Company . . . . . *
Agency — James Thomas Chirurg Company
Ohio Injector Co. 105
Agency — Fuller & Smith & Ross Inc.
Pacific Pumps, Inc. 19
Agency — The McCarty Company
Permutit Co., The . . . . . *
Agency — Cunningham & Walsh, Inc.
Prat-Daniel Corp. . . . . *
Agency — Hening & Company, Inc.
J. F. Pritchard (Equip. Div.) 131
Agency — Carter Advertising Agency

% Proportioneers, Inc. % 22
Agency — Hammond-Goff Co.
Raybestos — Manhattan, Inc. 20
Agency — Gray & Rogers
Read Standard Corporation ..... *
Agency — Davis & McKinney
Reliance Gauge Column Company ..... *
Agency — Carr Liggett Advertising Inc.
Republic Flow Meters Co. 114–115
Agency — Glenn, Jordan, Stoetzel, Inc.
Richardson Scale Co. ..... *
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Rockwell Mfg. Co. ..... *
Agency — Marsteller, Gebhardt & Reed, Inc.
Rohm & Haas Company ..... *
Agency — John Falkner Arndt & Company, Inc.
Roto Div. of Elliott Co. 121
Agency — Jos. S. Vogel & Co.
R-P & C Valve Division, American Chain & Cable 107
Agency — Reincke, Myer & Finn
R-S Products Corporation 48
Agency — Carl M. Craig Agency
Sarco Company, Inc. ..... *
Agency — Gus Binz Associates
Schutte and Koerting Co. 23
Agency — Harris D. McKinney Organization
Shell Oil Company ..... *
Agency — J. Walter Thompson Company
Simplex Valve & Meter Co., The 120
Agency — Cunningham & Walsh, Inc.
Sinclair Refining Co. ..... *
Agency — Morey, Humm & Johnstone, Inc.
Southern Coal Company, Inc. ..... *
Agency — Robertson & Buckley, Inc.
Standard Oil Co. (Indiana) 113
Agency — McCann-Erickson, Inc.
Stone & Webster Engineering Corporation 34
Agency — Harold Cabot & Co., Inc.
Subox, Inc. ..... *
Agency — Kirk B. Shivell, Inc.
Sun Oil Company 57
Agency — Gray & Rogers
Swartwout Company, The 6
Agency — Palm & Patterson
Taylor & Co., W. A. ..... *
Agency — Emery Advertising Corporation
Terry Steam Turbine Co., The ..... *
Texas Co., The ..... Back Cover
Agency — Erwin, Wasey & Company, Inc.
Thermix Corp., The ..... *
Agency — Hening & Company, Inc.
Treasury Department 118
United States Rubber Company ..... *
Agency — Fletcher D. Richards, Inc.
United States Steel Corp. ..... *
Agency — Batten, Barton, Durstine & Osborne, Inc.
Universal Atlas Cement Co. (Lummite Division) ..... *
Agency — Batten, Barton, Durstine & Osborne, Inc.
Vogt Machine Co., Henry 108
Agency — Farson & Huff
Vulcan Soot Blower Division, Continental Foundry & Machine Company ..... *
Agency — Davies and McKinney
Wallace & Tiernan Products, Inc. 125
Agency — Branstater-Hammond
Warren Steam Pump Co., Inc. 110
Agency — The Davis Press, Inc.
Western Chemical Company 127
Agency — Carter Advertising Agency, Inc.
Western Precipitation Corp. ..... *
Agency — Dozier, Eastman & Co.
Westinghouse Electric Corporation 35
Agency — Fuller & Smith & Ross, Inc.
Wheeler Mfg. Co., C. H. ..... *
Agency — The Roland G. E. Ullman Organization, Inc.
Wickes Boiler Co., The 101
Agency — Price, Hedrick & Tanner, Inc.
Wilson, Inc., Thomas C. ..... *
Agency — Michel-Cather, Inc.
Wing Mfg. Co., L. J. ..... *
Agency — Willard G. Myers Advertising Agency
Worthington Pump & Machinery Corp. 32, 42
Agency — James Thomas Chirurg Company
Yarnall-Waring Company 10–11, 62
Agency — Michener & Holland

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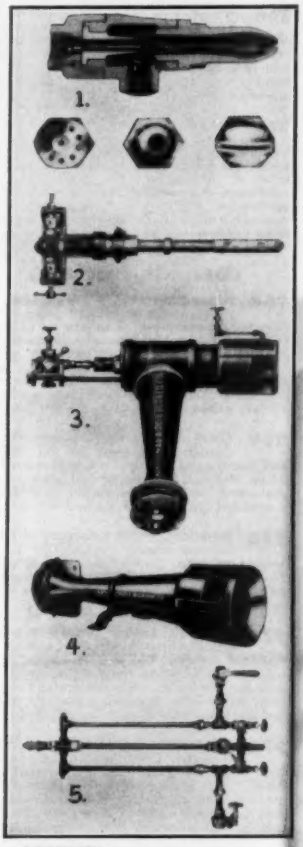

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(*Continued from page 131*)

raw water cooling, recirculation and removal of condensate. Fully illustrated. Foster Wheeler Corp.

265 Steam Condensers — Bulletin 102, 24 pp, is a comprehensive presentation of manufacturer's steam condensers and includes photos of six typical installations as well as a section of engineering data, a discussion of air removal equipment, and a chapter on condenser maintenance. Such special equipment as company's Wizard injector to seal small leaks while condenser is in operation, air erosion eliminators, divers lights and port gages are also described. Condenser Service & Engineering Co., Inc.

HEATERS, HEATING

266 Water Heaters — Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-pass, four-pass and six-pass designs, with tube bundles removable for inspection. Davis Engineering Corp.

267 Heat Exchangers — Bulletin 114, a small folder, gives concise information on company's Aero heat exchanger with balanced wet bulb control designed to cool engines or process equipment, coolants and lubricants, liquids and gases for processing operations. Cutaway drawing shows how exchanger operates, installation photos show some applications. Niagara Blower Co.

COAL, ASH HANDLING

268 Spreader Stoker — Bulletin 890, 40 pp, describes a spreader stoker with overthrow rotor designed to provide uniform fuel distribution. Discusses advantages of this type of stoker, including its efficiency in the burning of many grades of coal and in handling of fluctuating loads. Power-operated and hand-operated dumping grates and stationary grates are shown. Detroit Stoker Co.

269 Coal Handling Equipment — Modern equipment for the storage and handling of coal and ash is presented in 24-pp Bulletin 300. Illustrated, covers concrete and tile silos, cylindrical steel tanks, suspended steel bunkers. Gifford-Wood Co.

270 Spreader Stoker Selection — Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered. American Engineering Co.

271 Spreader Stoker Data — This is a file of three illustrated bulletins on spreader stokers. The first discusses seven reasons for selecting these stokers and describes their design, construction and operation; the second, dumping grates, the third, installations. Riley Stoker Corp.

272 Coal Scale — Bulletin 0250, 12 pp, describes a pressure-tight, automatic coal scale, its construction and operation. How beam system, electrical components and linkages are protected from exposure to coal dust, explained and illustrated. Typical installations pictured. Richardson Scale Co.

273 Efficient Coal Preparation — Facts and features concerning improved coal preparation for power plants are presented in this 8-pp illustrated booklet. Shows how coal is split, not crushed, by rolling ring principle utilized in company's equipment to provide better combustion and reduced ashpit loss through uniform low-cost coal sizing. Tables show relation of sizing of coal to ashpit loss. American Pulverizer Co.

274 Ash Handling Systems — This 24-pp booklet offers technical information on hydraulic and pneumatic ash and fly-ash handling systems. Compiled in question and answer form. Discusses elements and advantages of various systems and disposal schemes. Schematic drawings of arrangements under specific conditions, diagrams of arrangements included. Beaumont Birch Co.

PACKINGS

275 Pump Packings — Packings for use on reciprocating and centrifugal pumps are illustrated by photo and described in this 4-pp folder. It covers packings for practically all services. Johns-Manville.

276 Teflon Packings — Form AD143 offers 8 pp of information on packings and gasketing material made of Teflon, giving properties, typical and special applications. Styles and types are pictured, construction described, sizes given. Includes chapter on toxicology of Teflon at extremely high temperatures. The Garlock Packing Co.

277 Manual on Packings — Containing 84 pp of helpful engineering and ordering information, Catalog 40 covers packings for practically every service. Illustrates each type, gives sizes, construction and application details. Includes packaging recommendation charts, conversion tables. The Belmont Packing & Rubber Co.

COOLING

278 Industrial Dry Coolers — Illustrated Bulletin DC-50, 12 pp, presents company's line of dry cooling equipment for small, "in-between" and heavy-duty cooling jobs and includes three new models. Two of these are small "portable" units and the third a medium-size unit. Although designed primarily for cooling engine jacket water, they can also be used for cooling natural gas, lube oil, fluids of refining stages. Includes rating tables. The Marley Co., Inc.

279 Cooler with Fins — A new oil and water cooler and the several advantages provided by its improved design are described in 20-pp Bulletin 1020. Explains how company's LK-Fin Cooler, distinguished by use of helically-finned heat transfer elements instead of bare tubes, is a lighter, more compact and less costly unit for a given cooling service. Diagrams show comparisons of length and number of tubes and size of units for equivalent heat transfer surface. Also described are design details which provide effective heat transfer, permit free expansion of tube bundle, prevent leakage. The Griscom-Russell Co.

FANS, BLOWERS

280 Mechanical Draft Fans — An extensive line of mechanical draft fans for both forced and induced draft service is described in 20-pp Bulletin 168. Illustrated with drawings of typical fan types and photos of installations, also includes performance curves showing efficiencies of various types of fans. Gives construction features, drive arrangements, mounting methods. The Green Fuel Economizer Co., Inc.

281 Axial Flow Blowers — In this 6-pp illustrated bulletin are described axial flow blowers of both turbine-driven and motor-driven types. Gives capacity and dimensional data, operating range and specifications on both types. Also describes draft inducers. L. J. Wing Mfg. Co.

282 Blowers and Accessories — Engineering and dimensional information on low, medium and high capacity blowers is given in this recently released 6-pp bulletin. Pictures some installations, also accessories for use with the blowers. Blower-Stoker Div., Read Standard Corp.

OTHER EQUIPMENT

286 The ABC of CO^2 — An interesting, readable text covering the role of carbon dioxide in combustion efficiency, 16-pp illustrated Bulletin 452 discusses theoretical vs practical perfection of combustion and tells how to determine percentage of CO^2 in flue gases. CO^2 as a basis for figuring heat and fuel losses is also described and method of determining such losses explained. Includes scales of total heat losses of various types of coal, fuel oils and gas, also case histories of savings realized through increased CO^2 percentage. The Hays Corp.

287 Fundamentals of Hydraulics — Technical Bulletin B-4 is a newly revised 44-pp guidebook covering essential information on hydraulic systems, maintenance trouble-shooting and selection of proper fluids. Besides offering well-organized reference data to engineering personnel, this book is suggested as a training manual for maintenance supervisors, operators and apprentices. It features specially prepared phantom and cutaway drawings illustrating functions of basic types of valves, pumps, hydraulic motors, torque converters. Shows function of each component part. Sun Oil Co.

288 Transmission Belting — Catalog M-9922, 28 pp, gives detailed design, engineering and performance data on transmission belting. Tables on belt speeds, arc of contact, friction, horsepower correction, and service factors are included. United States Rubber Co.

289 Turbine Catalog Collection — This is a valuable collection of bulletins covering a complete description of solid wheel turbines. They feature cross section drawings of typical units for both moderate and high steam pressure conditions. Includes data on speed increasing and reduction gears. The Terry Steam Turbine Co.

290 Steels for Hot Spots — This is an 88-pp manual filled with information on steels for elevated temperature service. Includes a discussion of the general principles of high temperature behavior of ferrous materials and the factors influencing their behavior; a data section replete with tabular and graphical material covering mechanical properties of 21 steels. United States Steel.

291 Paints to Beat Corrosion — This 8-pp illustrated bulletin is devoted to company's line of anti-corrosive paints. Discusses their sub-oxide of lead base and other technical properties and points out savings in time and money afforded by the use of these rust-inhibitive coatings. Describes primers, finishing coats and single coats available; tells how to apply them. Also discusses painting of galvanized structures. Subox, Inc.

292 Dehydration Systems — This 4-pp bulletin presents pressure type and gravity type dehydration systems for cleaning, stabilising, and degasifying lubricating oils. Explains their features, sequence of operation. Illustrated; includes specifications, dimensions and weights. Bowser, Inc.

293 Chemical Cleaning Service — Reduced maintenance costs and outage time are among advantages of company's chemical cleaning service for steam equipment and water lines discussed in this 8-pp bulletin. Before-and-after photos show some actual cleaning jobs and several case histories are given. Company's service procedure and facilities are outlined. Dowell Inc.

CLASSIFIED ADVERTISING

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1 Smith Vaile, 5½ x 3½ x 5 Duplex Boiler feed pump.

1 Worthington, 5½ x 3½ x 5 Duplex Boiler feed pump.

1 American, 5½ x 8 x 12 Vacuum pump.

1 Karnak, 5 x 7 x 10 Vacuum pump.

1 25 hp Vertical Fire Tube Marion Boiler (recently retubed).

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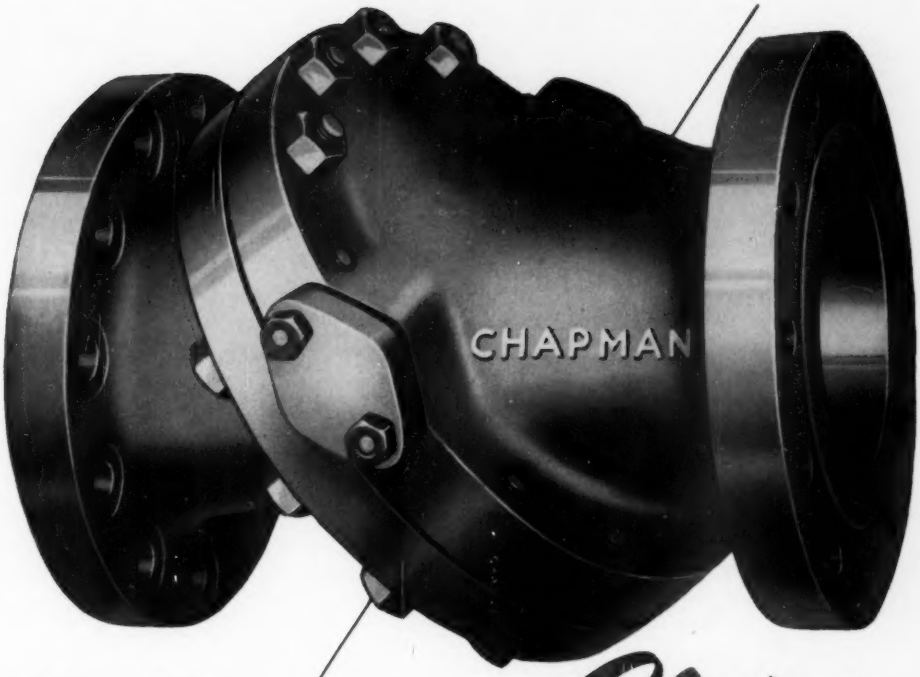

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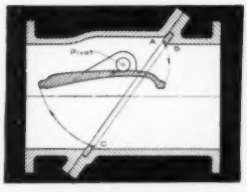

Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

There's no impact on closing — with this valve by Chapman. The balanced disc rides the flow smoothly — uses the fluid or gas itself to cushion the closing action. The disc lifts away from the seat easily on opening; closes quickly, positively—yet quietly.

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Chapman Tilting Disc Check Valves are available in either iron or steel. Write today for catalog with complete technical information.

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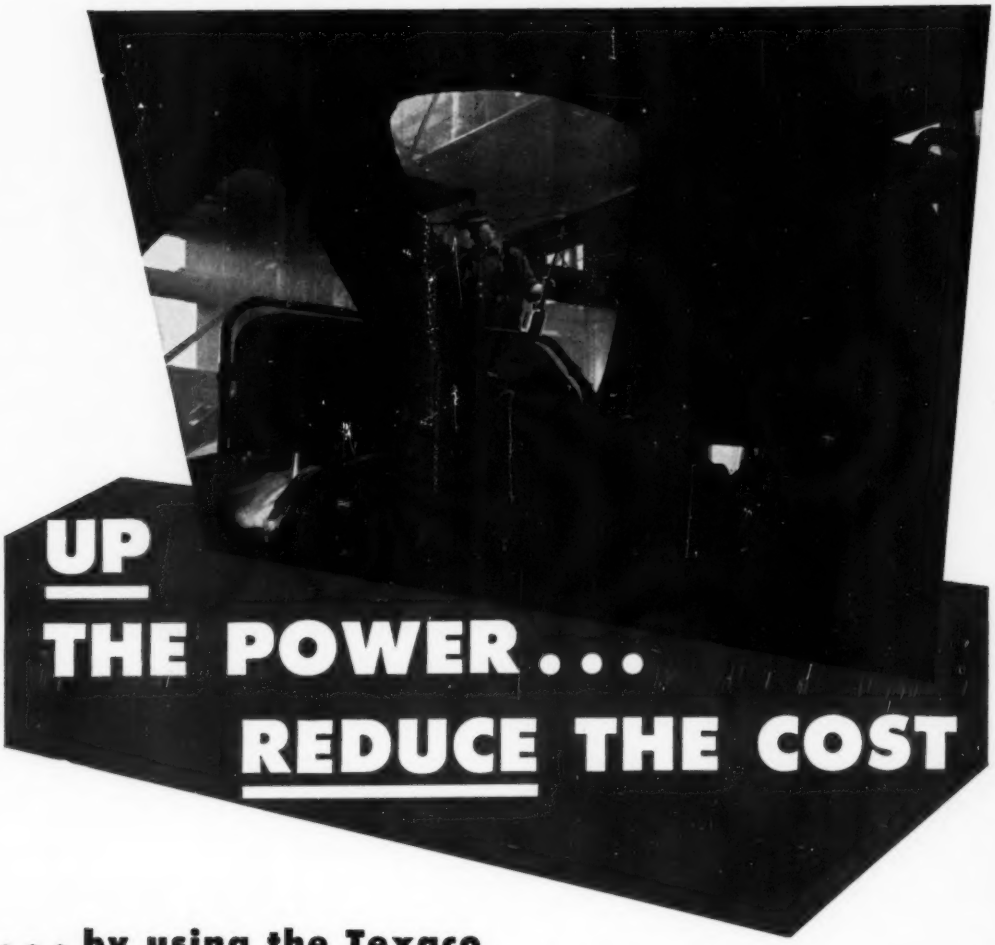

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